MANUAL OF ANATOMY

DANIEL JOHN CUNNINGHAM

1850–1909

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From identical Bronze Plaques in the Dissecting Rooms, Trinity College, Dublin, and the University of Edinburgh

CUNNINGHAM'S MANUAL
OF
PRACTICAL ANATOMY

REVISED BY

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TWELFTH EDITION

VOLUME ONE

GENERAL INTRODUCTION

UPPER LIMB LOWER LIMB

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PREFACE TO THE TWELFTH EDITION

IN the Eleventh Edition of this *Manual* the older order of dissection of the body as a whole—a sequence that depended on placing it first in the " lithotomy position "—was maintained. If the whole body has been allotted to different groups of dissectors, there is a certain convenience in beginning with the dissection of the perineum in relation to a time-table of days assigned to the earlier stages of the dissection of each part. But, even if the abdomen and pelvis are to be dissected at once, it is not now the practice in many dissecting rooms to begin with the perineum.

Moreover, it is increasingly common for the same students to dissect thorax, abdomen and pelvis of the same body and then to proceed to the lower limbs. In that case, dissection of the perineum may well be deferred to some later stage. In this edition of the *Manual*, therefore, the order of dissection has been altered so far as the abandonment of the " lithotomy position " necessitates, and the dissection of the perineum has been postponed so that it takes its natural place as a preliminary to dissection of the pelvis.

The consequent alterations in sequence and time-tables of the dissections of Abdomen and early stages of Head and Neck are explained briefly in the Introductions to Vols. II and III respectively; the changes do not affect dissection of the limbs, except in so far as the order of dissection of the Lower Limb may be modified if undertaken by the same dissectors as the pelvis (Vol. I, p. 189). In a few regions, other alternative methods are suggested, but here again

individual teachers can vary the instructions according to the plans that they favour.

The perennial question of anatomical nomenclature again requires some consideration. The nomenclature used since the ninth edition of this *Manual* has been that adopted by the Anatomical Society of Great Britain & Ireland at Birmingham in 1933. It was basically a revision of the Basle Nomina Anatomica (1895); it is known as the Birmingham Revision (B.R.), and a shortened Glossary showing the chief differences from the B.N.A. has been included in successive editions of the *Manual*. The B.R. was a notable advance towards a more generally acceptable system of nomenclature and has been consistently used in British textbooks and teaching.

But the movement towards revision of the B.N.A. as an international system continued, and at the International Congress of Anatomy, held at Oxford in 1950, an International Anatomical Nomenclature Committee was set up to deal with the matter and to report to the next Congress. With the B.N.A. again as a basis, this Committee—the several systems of the body being considered by international Sub-Committees—was able to submit a more or less complete list of agreed terms to the 1955 Congress at Paris, where it was approved. This List corrects many of the anomalies of the B.N.A., incorporates many of the improvements in the B.R., and it will doubtless be used in its Latin form in scientific publications as a matter of international convenience.

But no provision was made for its official acceptance by the constituent national Anatomical Societies; it allows a certain latitude for translation into the various vernaculars in which Anatomy has to be taught; and, moreover, a Standing Committee was set up at the Paris Congress to receive suggestions for amendments to be submitted to succeeding Congresses at five-yearly intervals. Some of the terms may thus be amended in 1960, and also there must clearly be a transition period during which new or modified terms in the Paris Nomenclature (P.N.) may become familiar

to teachers and students. It would be simpler for editors of text-books and teachers in Anatomy Schools at once to adopt the P.N. outright; but, as modifications will certainly be proposed, they must in the meantime do their best to facilitate the transition for their own nationals. For this purpose, editors must use their own personal judgement in the matter of retaining temporarily some of the more familiar terms with cross-references to the new and less familiar. In any case, so far as British Anatomy is concerned, important differences between B.R. and P.N. are fortunately few, and the editor of this *Manual* has thought it unnecessary to continue a full-scale Glossary. It seems sufficient during a transition period to use very occasional brackets in the text, *e.g.*, " Lateral Popliteal (Common Peroneal) Nerve ", and to indicate the principal changes in the Index to each volume.

Entries of two kinds will therefore be found in the Indices. In the case of new terms that have been adopted—many of them already familiar—the B.R. equivalents of some of them appear in cross-references, thus:

Canal, subsartorial (*see* canal, adductor);
Ligament, pectineal part of inguinal (*see* ligament, lacunar);
Corpora quadrigemina (*see* colliculi);

and in the case of B.R. terms temporarily retained, the P.N. terms likewise appear as cross-references, thus:

Nerve, dorsalis scapulae (*see* nerve to rhomboids);
Bursa, omental (*see* sac, lesser of peritoneum);
Trunk, brachio-cephalic (*see* artery, innominate).

In such cases the editor, as indicated already, has had to take personal decisions—all subject to reconsideration in subsequent editions as amendments may be proposed or terms accepted through use and wont; and he hopes that this procedure—which may perhaps appear to some to be arbitrary —will have the effect of introducing the Paris Nomenclature to readers of this *Manual* in a convenient manner and may facilitate the transition to a finally agreed English equivalent.

For this edition, the text-illustrations have been reviewed in all three volumes and, in addition to a few borrowings from Cunningham's *Text-Book*, 21 new drawings have been substituted for old illustrations, some of which had done duty since the first publication of the *Manual*. The new drawings are the work of Miss Nancy Joy, Toronto, of whose expert services the editor was glad to avail himself through the opportunity of her visit to Edinburgh. Some of the radiographic Plates also have been replaced by negative prints from more recent films, but the sequence of the Plates has been retained in each volume.

J. C. B.

EDINBURGH,
June 1957

EXTRACT FROM PREFACE TO THE ELEVENTH EDITION

This new edition has been prepared at a time when the long-drawn-out discussions on reform of the Medical Curriculum in British Schools have culminated in a new series of Recommendations by the General Medical Council. The Recommendations that deal with anatomical study and instruction emphasise the educational value of certain functional aspects of the subject, which incidentally have not hitherto been neglected in this *Manual* or in any progressive School; but at the same time they specifically endorse what has long been required of students of Medicine—the dissection of the whole body—thus giving official sanction, if that were needed, to the plain necessity that first-hand acquaintance with Regional Anatomy should be an essential part of medical education. The perennial question of detail, on which there is much difference of opinion, remains for solution.

A Preface is perhaps not the place for a dissertation on the principles of anatomical teaching; but this much may be said. Anatomical knowledge clearly must have a basis of factual and topographical information: Anatomy without detail would be of less value than "bricks without straw"; and experience shows that students denied the "straw" of anatomical information may be content, to the detriment of their clinical studies and the dismay of their clinical teachers, with the "stubble" they may pick up for themselves.

No doubt it is impossible to reach any final agreement on the body of details that must or should be known to every student of Medicine before he begins clinical study, and it

must be left to individual teachers, preferably with the advice of their clinical colleagues, to make their own selection. But a *Dissecting Manual* too closely shorn of detail is more likely to inculcate a habit of superficial observation than to concentrate the attention upon the things that alone are supposed to matter. It is indeed a common fallacy in criticisms of anatomical teaching that students are expected to remember every detail that may be mentioned: the judicious introduction of descriptive detail should be considered rather as one means of inducing that sense of topography upon which an appreciation of the value of anatomical detail in elucidating clinical problems may later depend.

With these considerations in mind, the text of this edition has undergone a thorough revision with one main object in view—the use of detail, not in itself of immediate essential value, as an element in scenic description as the student learns to find his way about the body and to appreciate the main features of the landscape. A considerable reduction in length has thus been attained; but the editor hopes that the original character of the *Manual* as a complete guide to dissection, combined with a readable topographical description, has not been impaired.

J. C. B.

DEPARTMENT OF ANATOMY
UNIVERSITY OF EDINBURGH
June 1948

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MANUAL

OF

PRACTICAL ANATOMY

GENERAL INTRODUCTION

FOR descriptive purposes the HUMAN BODY is divided into *Head*, *Neck*, *Trunk* and *Limbs*. The trunk is subdivided into the Chest or *Thorax* and the Belly or *Abdomen*; the abdomen is further subdivided into the *Abdomen Proper* and the *Pelvis*; and the lower end of the trunk, where the pelvis comes to the surface between the buttocks and between the thighs, is called the *Perineum*.

Dissecting the body region by region, the student of Anatomy acquires first-hand knowledge of the situation and relations of the various structures that compose it—Regional or Topographical Anatomy. Before he begins, he should have an elementary knowledge of the kinds of structures he will encounter, and for accurate description he requires an anatomical vocabulary which must include terms that define relative position precisely. These things are usually explained in introductory courses of lectures; but it is well to summarise them in the Introduction to a Dissecting Guide.

Terms of Position.—During dissection, the body, or any detached portion of it, usually lies horizontally on a table; but the dissector must remember that descriptive terms which refer to position are used as though the body were standing upright, with the upper limbs hanging by the sides but so rotated that the palms of the hands are directed forwards.

This attitude is known conventionally as the "anatomical position".

Superior or upper, therefore, does not refer to the position of a part that is nearer the dissector as he looks down on his dissection, but refers to the position of a part that is *nearer the head* of the supposedly erect body; and **inferior** means *nearer the feet.*

Anterior means nearer the front of the body, and **posterior** means nearer the back. In the trunk, *ventral* and *dorsal* may be used instead of anterior and posterior; these terms have the advantage of being applicable in any position of the body and are therefore used in Comparative Anatomy. (*Venter* = the belly; *dorsum* = the back.) In the hand, *dorsal* commonly replaces posterior, and *palmar* replaces anterior; in the foot, the corresponding surfaces are superior and inferior in the anatomical position, but those terms are usually replaced by *dorsal* (*dorsum* of foot) and *plantar.* (*Planta* = the sole.)

The **median plane** is an imaginary plane that divides the body into a right and a left half. The **anterior** and **posterior median lines** are the edges of that plane on the front and the back of the body. The term **median** usually refers to the position of a structure that is bisected by the median plane. **Medial** means nearer the median plane, and **lateral** means farther away from that plane. The ordinary English words, *inner* and *outer*, or their equivalents (derived from the Latin) *internal* and *external*, are to be used only in the sense of nearer the interior of a structure and farther away from the interior; in anatomical descriptions they are not to be used as equivalent to "medial" and "lateral" in the sense of relative distance from the median plane. External and internal (or outer and inner), however, are seldom used in the description of the structures in the limbs, for the words in common use are **superficial** for nearer the skin, and **deep** for farther away from it.

A plane through any portion of the body parallel to the median plane is called **sagittal**, and any vertical plane at right angles to these is called **coronal** (named from the position of two of the sutures of the skull).

Proximal and **distal** are terms that signify *nearer to* and *farther from* some agreed point. In a limb, the point agreed upon is the root of the limb; therefore, in a limb,

"proximal" and "distal" mean the same as "superior" and "inferior", except in the foot.

Middle, or its Latin equivalent *medius*, is the usual adjective denoting a position between upper and lower or between anterior and posterior, but **intermediate** is commonly used instead of "middle" for a position between lateral and medial.

Structures met with in a Dissection.—The first step in a dissection is the removal of the skin. That discloses the superficial fascia.

The **superficial fascia** is a fibrous, fatty covering that underlies the skin and is attached to it by fibrous strands. In the scalp, the back of the neck, the palms of the hands, and the soles of the feet, its attachment to the skin is very firm. In all other parts it is loose enough to allow the skin to be freely moved; and its elasticity enables it to bring the skin back into place again. The thickness of the superficial fascia depends upon the quantity of fat in its meshes, and therefore varies greatly in different bodies and in different parts of the same body; fat is absent from the parts of it that underlie the skin of the eyelid, the nipple and areola of the breast, and some parts of the external genital organs.

The deeper parts of the glands of the skin and of the roots of the hairs penetrate into the superficial fascia; and the *mammary gland*, which is composed of modified and enlarged skin glands, is developed in it.

In some regions—for example, in the groin—the deeper part of the superficial fascia is in the form of a distinct membranous layer. In two regions, it contains a thin sheet of muscle:—(1) in the front and side of the neck and the adjacent part of the chest, where the sheet of muscle is called the *platysma*; and (2) in the scrotum, where it is called the *dartos*.

The superficial fascia is a warm garment underneath the skin, for fat is a bad conductor of heat. When moderately fatty, it fills up the hollows and rounds off the irregularities at the surface of the body. In a muscular man, however, it is seldom thick enough to obscure the outlines of the muscles that lie near the surface, whereas it is usually thick enough to do so in women. The rounded contours and smooth outlines of a woman's figure, due to the greater quantity of fat in the superficial fascia, are a secondary sex-character.

The superficial fascia contains also the cutaneous blood-

vessels, lymph-vessels, and nerves on their way to and from the skin ; and a few lymph-nodes are embedded in it.

Blood-vessels are of three kinds—arteries, veins, and capillaries.

The **arteries** are the tubes that convey blood from the heart. Before the body is brought into the dissecting-room, it is embalmed by the injection of a preservative liquid into the arteries, and that is usually followed by the injection of coloured starch which distends the arteries and simulates the scarlet blood of arteries, making the smaller ones more apparent for dissection. The largest artery in the body is the *aorta*, which springs from the heart. It is about an inch in diameter. The largest artery of a limb is one-quarter or one-third of an inch in diameter. Arteries branch and re-branch, and thus become successively narrower and narrower; and those in the superficial fascia are so slender that the red injection seldom runs into them. The smallest arteries, which open into the capillaries, are known as **arterioles.** In many parts of the body the smaller arteries join one another, forming tubular loops. The union of branches of arteries in this manner is called an **anastomosis.** Obvious anastomoses occur around the joints of a limb, and they may be of importance in maintaining the circulation if a main vessel has to be ligatured. In other places the anastomosis of arteries provides for an even distribution of blood to the parts supplied ; notable examples are the "arterial circle" on the base of the brain, and the series of arcades formed by the arteries of the intestines.

The **veins** are the tubes that carry the blood back to the heart. They are wider and more numerous than the arteries. They usually retain their blood after death, and are therefore bluish or purple in colour. The lesser veins unite, like the tributaries of a river, to form the larger veins; and veins anastomose even more freely than arteries, forming **venous plexuses** in some parts of the body, *e.g.*, in the pelvis. Every artery in a limb is accompanied by at least one vein. Most of the superficial arteries and all the larger deep arteries are accompanied by a single vein ; the smaller deep arteries have two veins, one on each side, called **venæ comitantes,** united by channels that cross the artery. But, in the superficial fascia, there are numerous veins that do not accompany arteries ; they are fairly large, and can be easily seen, with

their anastomoses, through the skin in the living forearm.

The **blood-capillaries** are microscopic tubes that complete the circulatory system by forming a network in which the smallest branches of arteries—the arterioles—end and the smallest tributaries of veins begin.

The pumping action of the heart sends the blood through the arteries and capillaries and onwards through the veins. The force of the heart-beat is, however, becoming spent by the time it reaches the veins; the more sluggish flow of blood in them is aided by the movements of the muscles among which they lie—one of the important benefits of taking moderate exercise—and also by the movements of the thorax, for its enlargement with each inspiration draws venous blood into it as well as air. None the less, the flow in veins is liable to be retarded by slight impediments; and most veins, therefore, have **valves** to prevent or hamper any tendency to backward flow of the blood. The position of the valves of the superficial veins of one's own forearm can be seen if these veins are compressed at the elbow; the veins then become distended with blood, and the position of the valves is indicated by little, localised swellings or "beads".

It was the presence of these valves in the veins—first demonstrated publicly by Fabricius at Padua in 1579—that led William Harvey (1578–1657) to his great discovery of the Circulation of the Blood. The student should not omit to slit open veins in different parts of the body to observe the situation and structure of the valves.

In some parts of the body, *e.g.*, in the pads of the fingers and toes and in the walls of some organs, there are direct connexions between small arteries and small veins without the intervention of capillaries. These **arterio-venous anastomoses** are under the control of the nervous system; relaxation of the arterioles concerned thus allows the blood to by-pass the capillary bed.

The **lymph-nodes** are firm, gland-like structures that vary in size from a pin-head to a large bean; and they are the main source of lymphocytes, a variety of white blood-corpuscle. It is sometimes difficult to distinguish the smaller nodes from the pellets of fat amidst which they lie; but they are firmer in consistence, and though they vary in colour—they may even be quite black in the root of the lung, owing to deposit of

carbon particles which have been inhaled and taken up by lymph-vessels—they are seldom yellow like fat. In the limbs, they are largest and most numerous in the armpit and in the groin. Lymph-nodes are found usually in groups of three or four; the groups are named after the places where they lie; and it often occurs that several groups are linked together by lymph-vessels.

The **lymph-vessels** are very fine tubes that contain a clear liquid called **lymph.** The lymph is exuded from the blood in the blood-capillaries, and permeates all the tissues of the body to provide for chemical exchanges between tissues and blood. During increased activity of any organ or part of the body, the lymph-vessels carry off any excess which cannot be dealt with by the blood-capillaries and otherwise would accumulate in the tissues. The supply of lymph depends therefore on the activity of a part. There is a constant flow in the lymph-vessels that drain the alimentary canal in the abdomen, some part of which is nearly always at work; but from parts that are sometimes at rest, *e.g.*, the limbs, the flow is intermittent.

The lymph is collected from the tissues by a network of fine vessels, called **lymph-capillaries,** which are wider than blood-capillaries and are less regular in shape. They differ also in that they communicate with larger vessels in only one direction, whereas blood-capillaries receive their contents from one set of larger vessels and pass them on to another. The smaller lymph-vessels arise from the capillary network and carry the lymph to a lymph-node, where they end. The lymph passes through the node and is collected by other lymph-vessels that arise in the node. These vessels carry it onwards either to another node or to a larger lymph-vessel. The vessels that carry lymph to a node are called *afferent* vessels; those that carry it from a node are *efferent*. (*Ad* = to; *ex* = from; *fero* = carry.) As the nodes are linked together, the efferent vessels of one node are often the afferent vessels of another. The nodes that receive afferent vessels direct from a part of the body are known as the "primary" nodes of that part. The larger lymph vessels unite together like the veins to form wider and wider vessels, but the resulting main lymph-channels are no larger than small veins. The lymph is ultimately poured into the blood-stream, for the largest lymph-vessels (the longest and widest of which is

called the *thoracic duct*) end by joining the great veins at the root of the neck.

There is no pumping force, like that of the heart, to drive the lymph onwards. Its flow through the lymph-vessels depends merely upon the movements of the body aided by the suction of the blood descending through the big veins in the root of the neck. For the maintenance of the flow in one direction, valves are therefore provided, as in the veins; and they are so closely set that a distended lymph-vessel has a characteristic beaded appearance.

The lymph-vessels that lie in the superficial fascia drain the lymph from the skin. For the most part, they run along the superficial veins and ultimately converge upon the important groups of lymph-nodes situated at the junction of the limbs and trunk. Only a few lymph-nodes are found in the superficial fascia, and they lie in its deeper part ; nearly all nodes are situated deeply, usually close to the deep veins, along which the deep lymph-vessels also run.

The lymph-vessels of the superficial fascia are like silken threads—so slender that often they are not detected during the dissection. Indeed, it should be mentioned that, with the exception of the main, terminal lymph-vessels and some of the larger afferents of the principal groups of nodes, it is scarcely possible to display the lymph-vessels unless special methods of injection have been employed. Nevertheless, because of their great importance in the spread of disease—either bacterial infection or cancerous tumours—the dissectors must make every endeavour to find the groups of lymph-nodes as they dissect each part, and to learn which are the "primary" nodes for any area or organ.

The **nerves** are cords of a light grey colour or nearly white; they branch like arteries, and their branches often unite with one another. In a way, they resemble telegraph cables, because they are made of bundles of exceedingly fine filaments, called *nerve-fibres*, bound together by fibrous tissue; and they carry messages, which are called *impulses*. The impulses are sent through them from the central nervous system (*i.e.*, brain and spinal cord) to the various structures in the body, and from the structures to the central nervous system. The fibres that carry impulses from the central nervous system are called *efferent*, and those that carry impulses to it are *afferent*. The commonest outgoing impulses are

those to muscles to make them shorten or contract to move some part of the body; and they are therefore called *motor*. The commonest incoming impulses are from the skin and

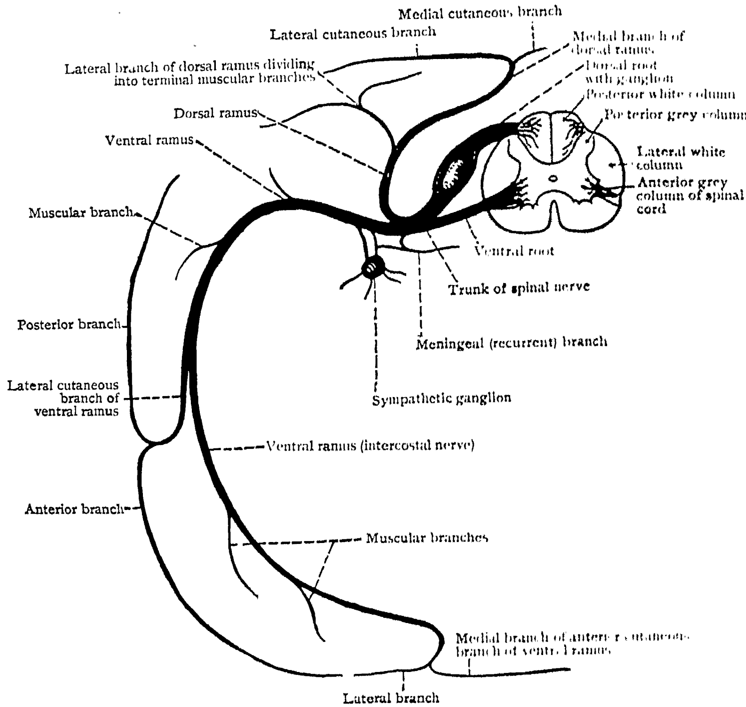


FIG. 1.—Diagram of a Typical Spinal Nerve. Note that the medial branch of the dorsal ramus is represented as distributed to skin, whilst the lateral branch terminates at a deeper level in muscle. Both branches, however, supply muscles; and in the lower half of the body it is the lateral branch that supplies skin.

other structures and convey information about sensations—touch, pain, heat, etc.—and are called *sensory*.

The largest nerve in the body is the *sciatic nerve*, which lies in the buttock and in the back of the thigh, and is about the width of the little finger and half its thickness. Most of the larger nerves in the limbs are of the thickness of a medium-size wax-taper; and the others are of all sizes from that down

to mere threads. In the superficial fascia, even the larger ones are fairly slender. At first, it may not be easy to distinguish a nerve from a small empty vein; but the vein can be easily stretched, while the nerve is firmer, and the nerve, being made of bundles of long fibres, is streaked lengthwise.

The nerves connected with the brain emerge from the skull or cranium, and are called *cranial nerves*. Those connected with the spinal cord are called *spinal nerves*; they have to escape from the vertebral canal—*i.e.*, the tunnel in the backbone that lodges the spinal cord. Nerves that supply a limb come from spinal nerves; and in the early stages of dissection reference has to be made to the names, numbers, and divisions of spinal nerves.

There are 31 pairs of **spinal nerves**—8 cervical, 12 thoracic, 5 lumbar, 5 sacral, and 1 coccygeal. They are named after the groups of vertebræ—*i.e.*, the segments of the backbone or vertebral column. But note that there are 8 cervical nerves and only 7 cervical vertebræ, and that there is only 1 coccygeal nerve though there are 4 segments in the coccyx.

Every spinal nerve is attached to the spinal cord by **two roots**—an anterior or ventral and a posterior or dorsal (Fig. 1).

The **ventral root** consists of bundles of *motor* fibres.

The **dorsal root** consists of bundles of *sensory* fibres. It is distinguished by the fact that it has a swelling on it, called the **spinal ganglion**, which is composed of microscopic *nerve-cells* mingled with nerve-fibres.

The two roots unite, immediately beyond the ganglion, to form the *trunk* of the spinal nerve. The union takes place at the intervertebral foramen through which the nerve-trunk leaves the vertebral canal.

The **nerve-trunk** is very short. The roots unite merely in order that the motor and sensory fibres may be mixed together; and the nerve-trunk, as it leaves the intervertebral foramen, splits into two divisions called the *ventral ramus* and the *dorsal ramus*. (*Ramus* = a branch.) Do not confuse the *roots* by which a spinal nerve arises with the *rami* into which it divides; nearly every ramus contains both motor and sensory fibres.

The **dorsal ramus** is the smaller. It passes backwards into the mass of muscle on the back of the body. There, it divides into a *lateral branch* and a *medial branch*. Both of these branches supply muscles, and one of them sends a branch

to the skin. Dissectors of the limbs look for these *cutaneous* branches of posterior rami when they are dissecting the hip and buttock and the region behind the shoulder-blade.

The **ventral ramus** runs in a lateral direction away from the vertebral column. The ventral rami of thoracic nerves run along the ribs ; the upper eleven are *intercostal*, and the twelfth is *subcostal* (*costa* = a rib) ; they end as *anterior cutaneous* branches on the front of the trunk. In their course they give off a *lateral cutaneous* branch, which divides into anterior and posterior branches. The ventral rami of the other spinal nerves are more or less pleated together to form what are called *nerve-plexuses*. Those of the cervical nerves (with part of the first thoracic) form two plexuses called the **cervical plexus** and the **brachial plexus.** Most of the nerves of the Upper Limb arise from the brachial plexus, and a few come from the cervical plexus. The brachial plexus lies in the neck and in the armpit ; dissectors of the Upper Limb combine with the dissectors of the Neck in displaying it. Those of the lumbar, sacral, and coccygeal nerves form plexuses that have the same names. Nearly all the nerves of the Lower Limb come from the **lumbar plexus** and the **sacral plexus.** These two plexuses lie near the backbone in the abdomen proper and pelvis ; they will be exposed by the dissectors of the Abdomen.

The fibres of the ventral or motor root arise from nerve-cells in the spinal cord. They run out into the ventral root, and onwards through the nerve-trunk and the rami into the various motor nerves. The fibres of the dorsal or sensory root arise in the nerve-cells of the spinal ganglion. Each sensory fibre, while still in the ganglion, splits into two branches—a central branch and a peripheral branch. Central branches run to the spinal cord, forming the sensory root of the nerve, and end around nerve-cells in the spinal cord or in the lower part of the brain. Peripheral branches run outwards through the rami and onwards into the sensory nerves. A sensory impulse starts at the end of a peripheral branch, runs in it to the ganglion, and onwards in a central branch into the spinal cord.

Deep fascia is the name given to the bluish membrane that lies under cover of the superficial fascia. It is thin, but dense and strong ; and the superficial fascia is loosely attached to it by fibrous strands. It clothes the muscles, investing

them so closely that it forms a tight sheath around the limb and preserves the contours of the limb. From its deep surface it sends in wide sheets that form partitions or *septa* among the muscles. In that way the deep fascia provides fascial sheaths for many of the muscles, and for the vessels and nerves that lie among the muscles; and parts of some muscles are attached both to the investing fascia and to the septa. Some of the septa are attached to the bones and to the ligaments of joints that lie deeply among the muscles. The investing fascia is attached to the ligaments of joints and to the parts of bones that come to the surface between muscles; and in certain places it is thickened to form strong, restraining bands, called *retinacula*, that hold tendons or sinews in position, and serve also as pulleys on which the sinews move—for example, at the wrist and ankle.

The **muscles** are the red flesh of the body, and form nearly half of the weight of the body. They are the active agents that produce movements, for they can be shortened or contracted at will to bring the parts to which they are attached closer together. The " actions " of muscles, however, are by no means simple; and the student must learn the various capacities in which muscles act in combination in any movement of a limb or other part of the body.

Each muscle has at least two attachments—one at each end. When the muscle contracts, it is usual for only one of those attachments to be moved. The attachment that usually remains fixed is called the **origin** of the muscle; the attachment that moves is its **insertion.** The limb-muscles are attached mostly to bones and deep fascia, but some are attached also to cartilages and to the ligaments of joints.

The red, fleshy part of a muscle is called its **belly.** The belly is composed of bundles of red *muscle-fibres* held together by white fibrous tissue. At the ends of a muscle the muscle-fibres lose their red, fleshy character and become white fibrous tissue; and by these white fibrous ends they obtain their attachments. In many muscles, especially at the origin, those terminal, white points are so short that the naked eye cannot see them; the muscle appears to be attached by red, fleshy fibres, and is, in fact, described as having a fleshy attachment. But many muscles terminate as long cords of white fibrous tissue by which they are attached. These cords have a greenish tinge, and are called **tendons** or sinews.

Those on the back of the living hand are easily seen, for they raise the skin and fasciæ into ridges when the fingers are bent back. In some cases, especially when the muscle is thin and wide, the tendon is not a slender cord but is a thin, wide sheet called an **aponeurosis.** (*Neuron* and *nervus* originally meant *sinew.*)

Tendons not only enable the power of a muscle to be transferred to a distance, as in the case of those that move the fingers, but they are related also to the structural form of muscles. The dorsal interossei of the hand (Fig. 84, p. 169) and of the foot exhibit a simple *bipennate* type of structure, two heads converging on a tendon like the barbs of a feather. The deltoid (p. 85) and the subscapularis (p. 92) are typical *multipennate* muscles, tendinous intersections greatly increasing the mass of muscle that can be attached to bony points.

In addition to a main vessel which enters many limb-muscles with the nerve at a distinct *neuro-vascular hilum*, numerous small arteries enter most muscles at irregular points ; and the blood is drained away by veins that accompany the arteries. Every muscle has at least one nerve of supply which conveys motor impulses to it to make it contract or relax, and carries sensory impulses from it to inform the central nervous system about its state of contraction.

Individual muscles may be made to contract by appropriate electrical stimuli applied to the skin over or near the sites of entry of their nerves ; a knowledge of these " motor points ", as they are called, is necessary for electrical diagnosis of the condition of a muscle and for its electrical treatment if paralysed.

When a muscle or a tendon passes over a bone or a ligament or another tendon, a **bursa** is placed between them to lessen friction and make movement easier. A bursa is a closed fibrous bag or sac, lined with a smooth membrane, called *synovial membrane*, which exudes an oily liquid called *synovia* to lubricate the surfaces. Normally the synovia is just enough to moisten the surfaces, but a bursa may be distended by excessive secretion caused by irritation, as in the case of " housemaid's knee ". For the same purpose, many tendons are enclosed in **synovial sheaths** made of white fibrous tissue and lined with synovial membrane.

Ligaments are strong bands of white fibrous tissue that

connect bony points. Most of them are found therefore at the **articulations** or **joints.**

In a few joints the connexion between the bones is entirely by fibrous tissue; in others, cartilage is the means of union; but the articulations of an adult limb are nearly all of the kind called **synovial joints.** The bones, where they touch or articulate with each other at a joint, are coated with the kind of gristle called *articular cartilage*. They are held together by a short, wide tube called the *articular capsule* of the joint. The capsule consists of an outer layer of strong white fibrous tissue—the *fibrous capsule*—and a lining of *synovial membrane*, which exudes *synovia* into the *joint-cavity*—*i.e.*, the space enclosed by the capsule. In many joints the capsular ligament is assisted in holding the bones together by additional ligaments and by extensions from the deep fascia, and is strengthened by thickenings of its own substance, which are named usually from their position, *e.g.*, radial and ulnar collateral ligaments of the elbow.

Osteology.—In a dissecting-manual, it is assumed that the dissector has an elementary knowledge of the bones, which students who are beginning the study of Practical Anatomy may have had no opportunity of acquiring. Therefore, as soon as they begin to dissect, they should procure, if possible, a set of bones for themselves, and learn from a text-book the *chief* characters of the backbone, the breast-bone, the ribs, and the bones of the part to which they have been assigned—omitting, in the meantime, the detailed description that includes the minor features and the attachments. In addition, they will doubtless have the opportunity of attending tutorial classes in Osteology, and of studying *radiographs* in which the form and relations of the bones may be seen, including, in the limbs of young persons, the **epiphyses** at the ends of the bones, which are related to their growth in length (see Plates IV, p. 31 and XIX, p. 170). But familiarity with the bones—essential foundation of knowledge of the topography of any part—can be attained only by constant reference during the dissection.

Landmarks and Surface-Anatomy.—Some parts of the skeleton can be neither seen nor felt till the soft parts are removed. But the outlines of many of the bones and the projecting parts of others can be distinguished through the skin, for they make prominences on the surface. Many

portions of bones that do not thus make themselves evident can, however, be felt quite easily when the finger is passed lightly over the places where they lie ; and others, that lie more deeply, may be felt if slight pressure is used. The students should identify these parts of the bones, on their own bodies or on one of their friends, as they read the description of the bones ; and they should examine them again on the dead body before they begin dissection, with constant reference to the articulated skeleton. They should do so until they are quite familiar with them both by sight and by touch, and can at once put a finger on any given point, whatever the position of the body may be. This is necessary because these visible and palpable parts of bones are the landmarks by means of which the position of the soft parts can be defined both in the dead body and in the living, and also because students of Medicine must begin at once to train their eyes to see all that can be seen and their fingers to feel all that can be felt.

While the study of landmarks is important before the dissection of a part is begun, the student must realise that it is essential to review the surface anatomy *after* the dissection is complete.

General Directions for Dissection — Instruments.— Sets of dissecting instruments vary in content, and the real essentials are scalpels and forceps. The dissector should have at least three scalpels of different sizes and two pairs of forceps, one with broad and the other with fine points. Equally essential is to see that the scalpels, which readily become blunted, are kept sharp; and the student must learn the correct method of honing and stropping a knife. Dissecting room equipment includes hones for general use, but a small carborundum hone and a strop are valuable adjuncts to a student's personal instruments It is important, too, to see that the blades of the forceps are adjusted so that they may be easily compressed without undue fatigue. In addition to the larger instruments of the dissecting room—such as saw, chisel and mallet, and bone forceps—other useful articles are the scissors, the "seekers", and the hooks, on chains and handles, found in most sets. Every medical student should possess also a hand-lens, and he should use it freely in the dissecting room to bridge the gap between naked-eye and microscopic anatomy in the study of the texture of tissues and organs.

Care of Parts.—The proper care of parts, so that they are kept moist and fit for dissection, is a routine duty of every student. After each period of dissection, the part must be wrapped carefully in a cloth, soaked in the preservative supplied in the dissecting room, and covered entirely with some waterproof material. Otherwise the part will dry up and harden, so that further dissection becomes difficult or impossible. This care is specially important in the later stages of the dissection of a limb, when extensive surfaces are exposed to the air, to preserve the joints in good condition.

Removal of the Skin.—The flaps of skin to be removed are marked out by cuts through the skin. *To make a Clean Incision*: Hold the blade at right angles to the skin, and drive the point through it till the superficial fascia is reached; you will know when you have reached the superficial fascia by the sudden diminution of the resistance. Then, incline the blade to an angle of 45° to the surface, and, pressing on the back of the blade with the forefinger, carry it steadily to the other end of the line of incision; and, lastly, bringing the blade to a right angle again, withdraw it.

To reflect a Flap of Skin.—Take hold of the most convenient angle with the broad forceps, and, with the edge of the scalpel, detach it from the superficial fascia. As soon as the angle is sufficiently detached, discard the forceps, grip the skin with thumb and forefinger, keep it tense, and, from one margin of the flap to the other, draw the edge of the knife across the skin at its junction with the superficial fascia—always keeping the edge against the skin. Do not take any fat away with the skin, else the small vessels and nerves that lie in the fat near the surface will be injured.

Dissection of the Superficial Fascia.—As soon as the skin is removed, the superficial fascia is dissected in order that the superficial vessels and nerves may be exposed and examined. The nerves and the arteries are all slender. They spring from the larger nerves and arteries that are more deeply placed. They pierce the deep fascia, and lie at first between the deep fascia and the superficial fascia; but they gradually pass through the superficial fascia to end in the skin. Each of the arteries is accompanied by a slender vein. Besides those small veins that accompany arteries, there are several larger veins that lie more superficially; but they also ultimately pierce the deep fascia to end in the more deeply placed veins.

To remove the Superficial Fascia.—First, cut through it down to the deep fascia along one edge of the area or according to the dissection instructions; if your knife is sharp, you may feel increased resistance when it reaches the deep fascia. Next, raise the cut margin of the superficial fascia with the forceps or your fingers and draw it away, cutting the fibrous strands that attach it to the deep fascia, and keeping the edge of the knife directed towards the deep fascia, in order to remove the whole thickness of the superficial fascia. As you come upon the superficial nerves and vessels, separate them from the superficial fascia, clean the fat off their surfaces, and leave them lying on the deep fascia.

In tracing the nerves and their branches through the fat, use the knife with caution. Indeed, a great deal of dissection can be done with the forceps or a blunt dissecting-hook, the knife being called into use to remove the superficial fascia from the spaces between the superficial structures after they have been isolated.

Deeper Dissections.—When you have removed all the superficial fascia from the area under dissection, and have studied the superficial structures, examine the characters and connexions of the deep fascia, and then remove it in order to expose the muscles and other deep structures. The deep fascia not only clothes the muscles but also gives attachment to many of them; the cleaning of a muscle—that is, the removal of the fascia from it—is therefore not always easy.

To clean a Muscle.—If necessary, put the muscle on the stretch by adjusting the limb. Define the margins of the muscle. Cut boldly through the deep fascia until the red bundles of the muscle are exposed. Seize the cut edge of the fascia, and put slight traction upon it. Keep the edge of the knife playing against the muscle to ensure the entire removal of the fascia. Carry the blade in the direction of the muscular bundles, changing direction as the course of the bundles alters.

The cleaning of the deeper muscles and of the deep surfaces of the more superficial muscles requires the removal of fat as well as of fascia. Take care throughout not to injure the nerves of supply. The nerves in the greatest danger are those that supply the more superficial muscles, for almost all of them enter the muscles through their deep surfaces.

It is more important to define the ends of a muscle and

verify its attachments than to spend time in attempting to clean off every particle of fascia from its surface.

To clean the Deeper Vessels and Nerves.—This means merely the piecemeal removal of the fat and loose fibrous tissue in which they are embedded. Begin with the main trunks. Clean them; trace their branches, and clean them also. This work is often very tedious; and dissectors often find that they are hampered (especially in the thigh) by the veins and by the branches of arteries that supply muscles. Keep the main venous trunks and most of the arteries, have no hesitation in removing the veins that accompany the smaller arteries, or in dividing the smaller arteries that supply muscles, if they are in the way. But be careful of nerves. They are much more constant in position than arteries. Trace all of them to their destinations and leave them uninjured.

Variation.—The human body, like all living things, is subject to variation. Apart from general features—stature, build, head-form, facial configuration—and fine details such as the well-known finger-prints, which together confer bodily individuality, all the systems and organs vary, more or less, from body to body. The student must not expect, therefore, to find everything exactly as described in a Dissecting Manual which, being primarily a guide, can deal only with the usual or average arrangement. The true bible of the student of Anatomy is the body itself; and he should welcome the opportunity that dissection provides of perusing it for himself as an original investigation. Thus he will cultivate that faculty of observation which will stand him in good stead in his later clinical work.

Some variations are of direct clinical importance, such as the arrangement of the superficial veins of the forearm and even the course of main arteries. Others, such as variations in the attachments of muscles (*e.g.*, an extra head of the biceps muscle of the arm), the absence of a usual muscle or the presence of an unusual one, may be chiefly of evolutionary significance. There is also the class of congenital malformations, not commonly seen in the dissecting room, which may be of great functional importance. Position of organs, *e.g.*, in the abdomen, may vary too; and there are more subtle variations, such as the form of the living stomach, which can be demonstrated by appropriate X-ray methods. The systematic noting of variations as they are observed is a

most useful exercise, notwithstanding that most of them will be found recorded in the larger text-books and in special works which may be consulted as occasion serves.

Anatomy of the Living Body.—It has sometimes been made a reproach to anatomical studies that they are concerned with dead, preserved material, and that the student thereby receives false impressions that he is in danger of transferring to the living body. But, apart from opportunities of attending autopsies of the recently dead or of observing living tissues at surgical operations, it is obvious that the student must have time to examine the structure of the body in detail, and that this implies embalming of the cadaver. It is true that embalming alters the texture and appearance of the tissues, and that hardening agents, such as formalin, produce an unnatural rigidity of muscles and organs. On the other hand, these agents, used in moderation, do preserve the form of organs at the time of death and thus maintain their relations to each other; and no sensible student is likely to imagine that the healthy liver in the living body is incapable of moulding itself to other organs as the diaphragm rises and falls, or that the living lung is a static organ because he finds them so in the embalmed cadaver that he dissects.

These remarks are made, however, to emphasise the importance of cultivating an attitude of mind that looks to dissection as a means to an end: and that end is understanding of the body as a living organism. The basis of that understanding is the topography of the body, of which real knowledge can be acquired only by personal contact. But it is not enough merely to supplement dissection by Surface Anatomy on the living model and by radiographic demonstration of the relations and changing form of organs in the living body. The student of Anatomy must always keep in mind the indissoluble relation between structure and function, as in the simple case of the venous valves or in the more complex arrangement of the heart, where gross structure is meaningless without reference to the circulation of the blood. So, in every system of the body, structure and function are but two aspects of the same study: the attachments of muscles must be related to the actions of which they are capable; the form of joints and the arrangement of ligaments and muscles around them must be studied with reference to movements and stability: and in tracing the nerves the student must

PLATE I

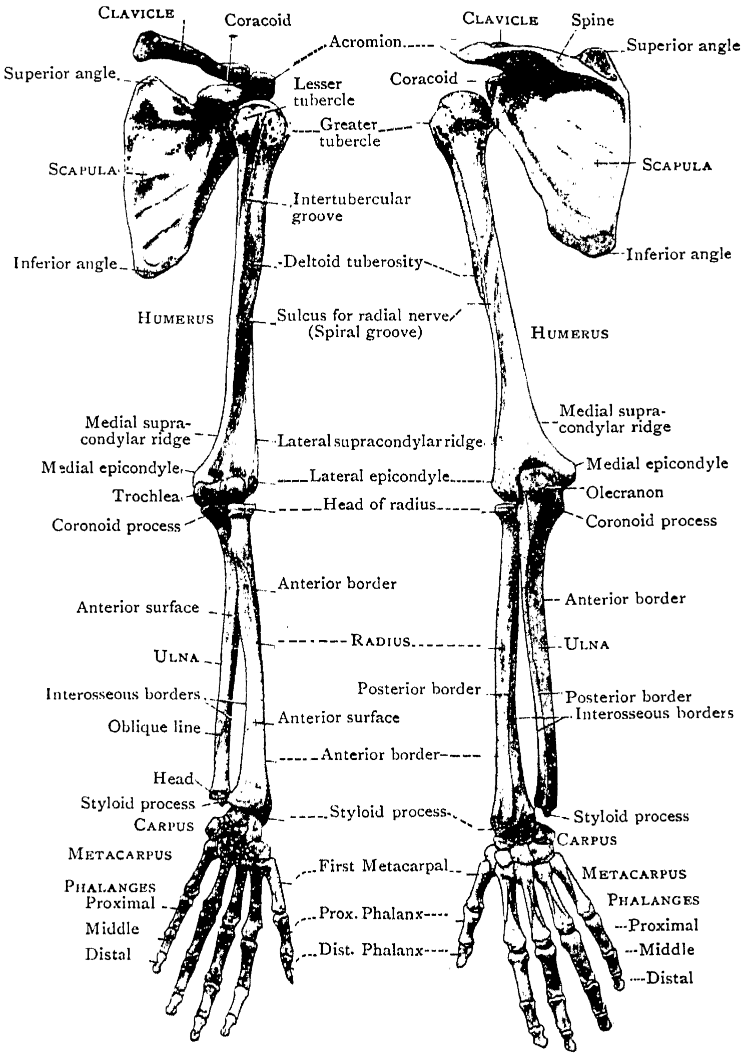


FIG. 2.—Bones of Left Upper Limb.

Anterior view. Posterior view.

[*Facing p.* 18

PLATE II

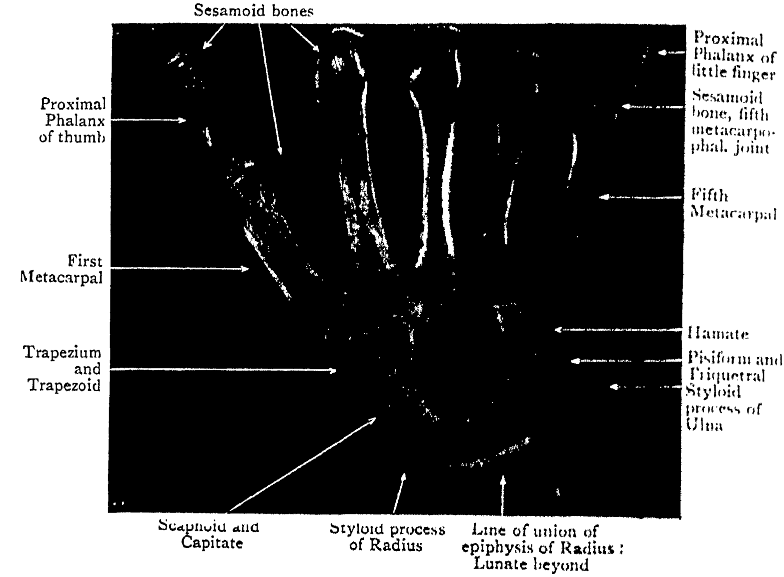


FIG. 3A.—Radiograph of Wrist and Palm of girl aged 17.

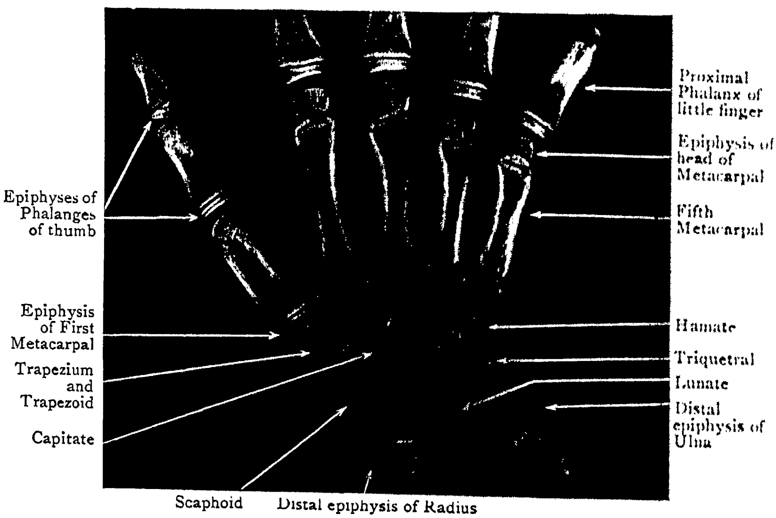


FIG. 3B.—Radiograph of Wrist and Palm of girl aged 7.

[*Facing p.* 19

constantly ask himself what functional groups of muscles they supply; from what areas of skin they convey sensory information; and what would be the effect if this or that nerve were to be compressed by disease or severed by injury. These are simple examples of the relation between form and function which is manifest throughout the body and in the intimate details of the structure of organs—the most perfect example is the central nervous system, brain and spinal cord. It is the attitude of mind that counts—the approach to Anatomy not as a dead subject but as the study of a living, functioning organism. Thus it is the indispensable foundation not only of Physiology and Pathology but also, with these subjects, of Clinical Studies, through appreciation of the anatomical basis of the signs and symptoms of disease.

UPPER LIMB

Introduction.—The parts of the Upper Limb are the *shoulder*, the *upper arm* or brachium, the *forearm* or antebrachium, and the *hand* or manus.

The region of the **shoulder** includes more than the familiar prominence at the upper end of the arm. It includes also:—(1) The **axilla** or armpit; (2) the **scapular region** or the parts around the shoulder-blade; and (3) the **pectoral region** on the front of the chest. (*Pectus* = the breast.) The bones of the shoulder form the *shoulder-girdle*. They are the **scapula** or shoulder-blade and the **clavicle** or collar-bone (Figs. 2, 25, 37). They articulate with each other at the top of the shoulder to form a joint called the **acromio-clavicular joint**; and the clavicle articulates with the upper end of the sternum or breast-bone to form the **sterno-clavicular joint.**

The **upper arm** is the part between the shoulder and the *elbow* or cubitus. Its bone is called the **humerus**, which articulates with the scapula to form the **shoulder joint.**

The **forearm** extends from the elbow to the wrist. It has two bones—the **radius** and the **ulna.** They articulate with the humerus to form the **elbow joint**; and they articulate with each other, at their upper and lower ends, to form the **proximal** and **distal radio-ulnar joints.** When the forearm is held so that the palm of the hand looks forwards (supination), the two bones are parallel—the radius on the lateral side of the ulna. When the hand is turned so that the palm looks backwards (pronation), the radius lies obliquely across the front of the ulna.

The **hand** is subdivided into: (1) The *wrist* or carpus, (2) the *hand proper* or metacarpus, and (3) the digits (*thumb* and *fingers*).

The skeleton of the **wrist** is a group of eight little bones called **carpal bones**, arranged in two rows—an upper and a

lower (Figs. 2, 3, 75). They articulate with one another to form **intercarpal joints**; and the upper row articulates with the radius to form the **radio-carpal** or **wrist joint.** On the back of the wrist, they are near the surface, partially under cover of the tendons that pass over the lower ends of the radius and ulna; on the front, they are to a large extent obscured by the ball of the thumb and the ball of the little finger.

The **hand proper** has a skeleton of five **metacarpal bones.** They correspond to the five digits and are numbered 1 to 5, beginning with the thumb. At their proximal ends or bases, they articulate with the lower row of carpal bones, forming **carpo-metacarpal joints**; and there are **intermetacarpal joints** between the bases of the medial four.

The **digits** are named :—*Thumb* or pollex; *forefinger* or index; *middle finger* or digitus medius; *ring finger* or annularis; and *little finger* or minimus. The bones of the digits are called **phalanges.** The thumb has two phalanges; the other digits have three. The proximal phalanx articulates with the head of a metacarpal bone to form a **metacarpo-phalangeal joint.** The middle one articulates with the other two to form **interphalangeal joints.** On the front of some of the metacarpo-phalangeal joints there are, occasionally, little nodules of bone called **sesamoid bones** (Fig. 3A).

PECTORAL REGION AND AXILLA

The dissection of the Upper Limb begins with the body supine, *i.e.*, lying on its back. The thorax should be raised to a convenient height by means of blocks, and a long board placed under the shoulders for the purpose of supporting the limbs when they are abducted from the sides.

Until the dissection of the axilla is completed, the dissectors of the Upper Limb and of the Head and Neck will find it advantageous to arrange to work at different hours. The dissectors of the Head and Neck, at this stage, are engaged on the dissection of the posterior triangle of the neck, and that cannot be well done unless the limb is placed close to the side and the shoulder depressed. For the dissection of the axilla, the limb should be stretched out at right angles to the thorax. A compromise between these two positions results in discomfort to the dissectors of both parts.

Five days are normally allowed for the surface-anatomy and dissection of the pectoral region and axilla. The following

time-table will be found useful in regulating the amount of work which should be carried out on each day :—

First Day.—(*a*) Surface-anatomy; (*b*) reflexion of skin; (*c*) cutaneous vessels and nerves; (*d*) fascia of pectoralis major and axillary fascia; (*e*) cleaning and reflexion of pectoralis major.

Second Day.—(*a*) Clavi-pectoral fascia and structures that pierce it; (*b*) removal of clavi-pectoral fascia and dissection of structures behind it.

Third Day.—(*a*) Cleaning of pectoralis minor; (*b*) contents of axilla below level of pectoralis minor.

Fourth Day.—(*a*) Reflexion of pectoralis minor; (*b*) remaining contents of axilla; (*c*) serratus anterior; (*d*) posterior wall of axilla; (*e*) reflexion of subclavius; (*f*) sterno-clavicular joint and disarticulation of clavicle at that joint.

Fifth Day.—Study of brachial plexus and general review of axilla and its contents.

Surface-Anatomy.—The **clavicle** lies between the neck and the front of the chest, and can be both felt and seen. It extends from the top of the shoulder to the upper end of the **sternum.** Draw your finger along it from one end to the other. Note that, in its medial two-thirds, it is curved with its convexity forwards, to give room for the passage of vessels and nerves between the neck and the axilla. The medial end of the clavicle (Fig. 4) articulates with the sternum; it also overrides the top of the sternum, and therefore produces a prominence that is easily felt. The prominence is, however, slightly masked by a part of the **sterno-mastoid muscle**—the muscle which extends from the sternum and the clavicle to the skull behind the ear and rises as a strong, blunt ridge on the living neck when the face is turned towards the other side.

Place the tip of the index finger in the *suprasternal notch*, *i.e.*, the hollow at the upper end of the sternum between the clavicles, and draw it downwards along the median line. About two inches below the upper end of the sternum, a blunt, transverse ridge is distinctly felt. That ridge marks the *sternal angle* at the union of the *manubrium* with the *body* of the sternum. It is the best landmark on the front of the chest, for it can be felt even in obese subjects, and it is often visible. The **cartilage of the second rib** joins the side of the sternum at the sternal angle. The second rib is therefore more easily identified than any other. To find one of the other ribs, find the second and count downwards from it. The anterior part of the **first rib** is about an inch above the second, and is masked by the clavicle. Continue

to draw the finger down over the sternum. At the lower end of the body of the sternum, the finger sinks into a shallow depression. That is the **epigastric fossa** or "pit of the stomach". The bony, but slightly yielding, structure felt on the floor of the fossa is the third or lowest piece of the sternum, and is called its **xiphoid process.** The right and left boundaries of the epigastric fossa are the **cartilages of the seventh pair of ribs.** Verify all these points on the articulated skeleton.

The **nipple** is rather variable in position, even in the male; but usually it is opposite the space between the **fourth** and **fifth ribs,** and is a guide to their position; and it is near their junction with their cartilages. Measure its distance from the median plane; it is usually about four inches. (The dissector's own hand is a rough measure. A man's hand is about four inches across, and his thumb about one inch wide.)

Come back to the clavicle. With the eye, divide it into thirds. Below the junction of the lateral and intermediate thirds, there is a depression called the **infraclavicular fossa.** The soft bulging at the medial side of the fossa is part of a large muscle, called **pectoralis major,** that lies on the front of the chest and in the anterior wall of the axilla. The prominence on the lateral side is the anterior part of the **deltoid muscle,** which clasps the shoulder. Put your finger in the infraclavicular fossa an inch below the clavicle, and press laterally under the deltoid. The bone felt there is the **coracoid process** of the scapula, and, though felt only indistinctly, it is frequently referred to as a landmark (Figs. 2, 8, 16).

The lateral end of the clavicle articulates with the medial margin of the acromion of the scapula. The **acromion** is a flattened piece of bone about an inch wide that lies in the top of the shoulder. (*Acron* = summit; *omos* = shoulder.) The upper surfaces of acromion and clavicle lie in nearly the same plane; the **acromio-clavicular joint** is therefore inconspicuous; but it can be detected easily if the limb is moved.

Abduct the arm. That is, draw it away from the trunk. The hollow of the **axilla** and the two rounded folds that bound it in front and behind are brought into view. The **anterior fold** encloses part of the **pectoralis major** muscle and part of the **pectoralis minor,** which is behind the major. The **posterior fold** encloses two muscles, called teres major and latissimus dorsi. The **teres major**—a stout, round muscle —extends from the lower angle of the scapula to the upper

part of the shaft of the humerus. The **latissimus dorsi**—wide and thin—lies in the lower part of the back (Fig. 24), but narrows to form a flattened tendon, which, as it approaches the humerus, winds round the teres major (Fig. 16). Draw the arm well from the side. The edge of the latissimus dorsi then raises up a distinct ridge of skin that runs downwards and backwards; the lowest rib that the ridge crosses is the **eleventh rib.** Grip the posterior fold between finger and thumb: the different consistence of the fleshy teres and the tendinous latissimus can be distinguished through the skin and fasciæ. Note that the posterior fold reaches lower down than the anterior, and that therefore the structures in the lowest part of the axilla have no muscle in front of them.

Place the fingers in the **axilla** and examine its walls. The **anterior wall** is soft and fleshy. So is the **posterior wall**; but the lateral margin of the **scapula** can be felt in it. The **ribs** are felt in the **medial wall**—covered with a wide muscle called **serratus anterior.** The **lateral wall** is narrow. The softer parts felt in it are two muscles—the **biceps brachii** and the **coraco-brachialis**; the hard part is the neck of the **humerus** and the upper part of its shaft. Some of the large nerves of the axilla can be rolled between the fingers and the bone; and in the living limb the **axillary artery** can be felt beating. Push the fingers well up into the axilla and rotate the arm: the globular **head of the humerus** can be felt indistinctly.

Dissection.—Reflexion of Skin: *Incisions* (Fig. 4):—(1) Along the median line of the body from the suprasternal notch to the tip of the xiphoid process. (2) Upwards and laterally from the tip of the xiphoid process to the nipple. Encircle the dark patch of skin (areola) around the nipple, and continue the incision along the anterior fold of the axilla to the arm. As soon as it reaches the arm, carry it downwards about three inches, and then transversely across the front of the arm to its lateral border. (3) From the tip of the xiphoid process transversely across the front and side of the chest to the plane of the posterior fold of the axilla. (4) From the upper margin of the sternum along the clavicle to its acromial end, if that incision is not already made by the dissectors of the Head and Neck.

Reflect the flaps of skin thus marked out (1 and 2, Fig. 4), beginning in the median plane at one of the angles. Do not detach the flaps, but leave them hanging by their lateral ends, in order that they may be replaced when dissection for the day is finished. Leave the small patch around the nipple.

As the reflexion proceeds, note that the connexion between the superficial fascia and the skin is stronger in some places than in others. In the female, definite fibrous strands will be found passing from the mammary gland to the skin.

Superficial Fascia.—In this region the fat of the super-

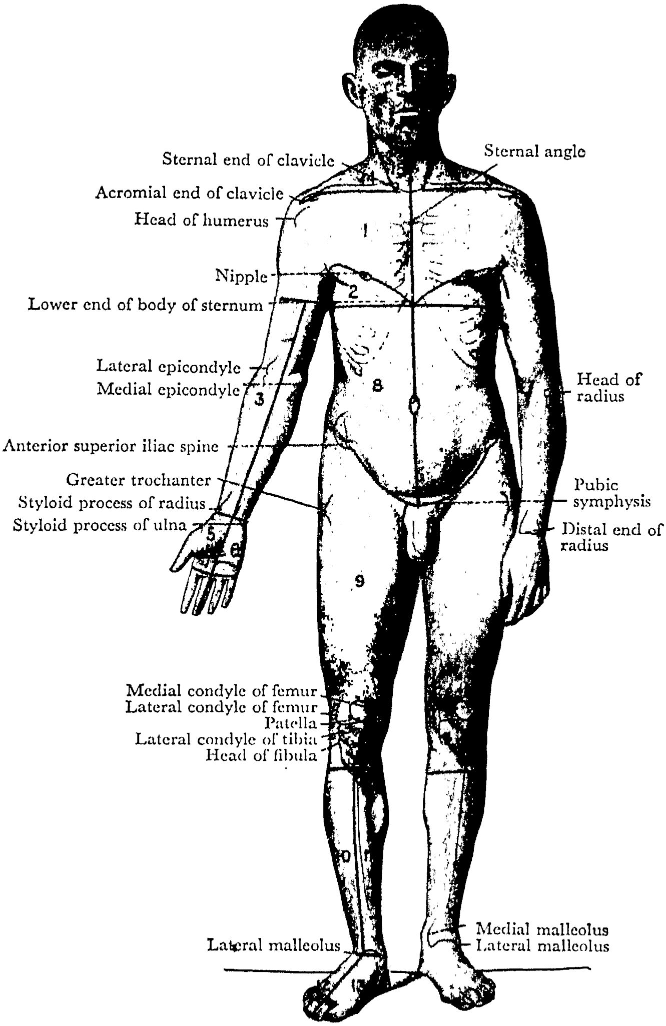


FIG. 4.—Landmarks and Incisions. For the bony landmarks of the Upper Limb, cf. Fig. 2, Pl. I, and the radiographs in other Plates.

ficial fascia is not usually very plentiful except in female bodies, where it is abundant in the region of the mammary

gland. Near the clavicle a vertical reddish striation is usually visible through the fat; it is due to the lower part of the *platysma*, a thin, subcutaneous muscle of the neck that extends down over the clavicle into the upper part of the front of the chest.

Cutaneous Nerves and Vessels.—The nerves and vessels that pass through the superficial fascia to the skin must now be sought. They are:—

Supraclavicular nerves, from the cervical plexus.
Anterior cutaneous branches } from intercostal nerves (*i.e.*, from
Lateral cutaneous branches } ventral rami of thoracic nerves).
Cutaneous arteries derived from deep arteries. Cutaneous veins.

Dissection.—Cut through the superficial fascia along the margin of the sternum. Lift its cut edges, and find the *anterior cutaneous nerves* as they pierce the deep fascia at the sternal ends of the intercostal spaces. They are very slender, but their greyish, streaked appearance distinguishes them from surrounding tissues; and the accompanying arteries, if injected, are guides to them. Trace their branches medially and laterally as far as possible.

Next, cut carefully through the superficial fascia and the platysma along the upper border of the clavicle, looking for the slender *supraclavicular nerves* as you reflect the fascia downwards. Trace the nerves as they stream downwards across the clavicle through the platysma into the superficial fascia of the shoulder and the front of the chest.

Thirdly, beginning at the arm, cut through the superficial fascia along the anterior fold of the axilla and continue the cut downwards and in a medial direction for three or four inches. Reflect the cut edges of the fascia, and look for the *anterior branches of the lateral cutaneous nerves* as they pierce the deep fascia at the lower border of the pectoralis major. Trace them medially through the superficial fascia.

The **supraclavicular nerves** arise in the neck from the third and fourth cervical nerves. They spread out as they descend, pierce the deep fascia of the neck, cross the clavicle under cover of the platysma, and run downwards to supply the skin that overlies the deltoid and pectoralis major muscles as far down as the level of a horizontal line drawn from the second costal cartilage. They are named, according to their positions, anterior, middle and posterior supraclavicular nerves (Fig. 5). The *anterior*—one or more—cross the medial part of the clavicle. The *middle*—two or three—pass over the middle of the clavicle. The *posterior*—one or more—cross the lateral third of the clavicle, and they will be followed to the skin of the shoulder afterwards.

The **anterior cutaneous nerves** are the terminal branches of the intercostal nerves and are very slender. They emerge from the intercostal spaces, and pierce the pectoralis major muscle and the deep fascia close to the sternum. One will be found in each intercostal interval except the first and, occasionally, the second; they give slender twigs to the skin over the sternum, and larger branches which run laterally and may be traced as far as the anterior fold of the axilla.

The small arteries that accompany those nerves are the *perforating branches* of an artery—the *internal mammary*—

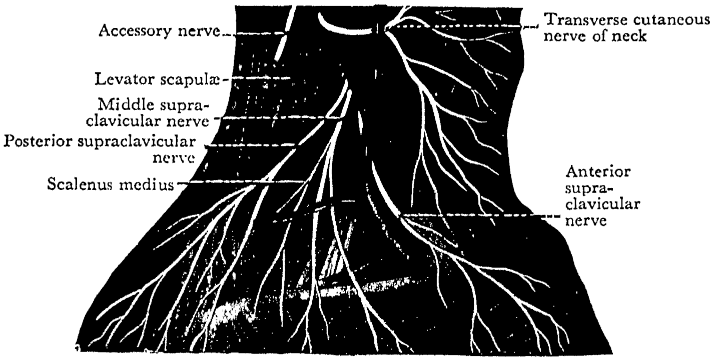


FIG. 5.—Supraclavicular Branches of Cervical Plexus.

which descends in the thorax immediately behind the costal cartilages. The perforating arteries of the second, third and fourth spaces are fairly large in the female (especially the third), for they send branches to the mammary gland.

The **lateral cutaneous nerves**, much larger than the anterior, also arise from the intercostal nerves, and appear on the side of the thorax a little behind the anterior fold of the axilla; they will be examined when the axilla is dissected.

If the subject is female, the mammary gland should now be dissected, but it is well to take note of its position and connexions before beginning. Dissectors of male subjects should take the first opportunity of studying a dissection of the gland in a female subject.

The Breast.—The mamma or breast is made up of:—(1) the mammary gland, (2) the superficial fascia in which the gland is embedded, and (3) the overlying skin, including the nipple and the areola around the nipple.

In the male, the mammary gland is quite rudimentary. The nipple is small and pointed, and the areola is surrounded by sparse hairs, which are never present in the female.

In the female, the **mammary gland** is situated on the front of the thorax and also, to some extent, on the side. It lies *in* the superficial fascia, and its smooth contour is largely due to the invasion of its substance by the fatty tissue of that fascia.

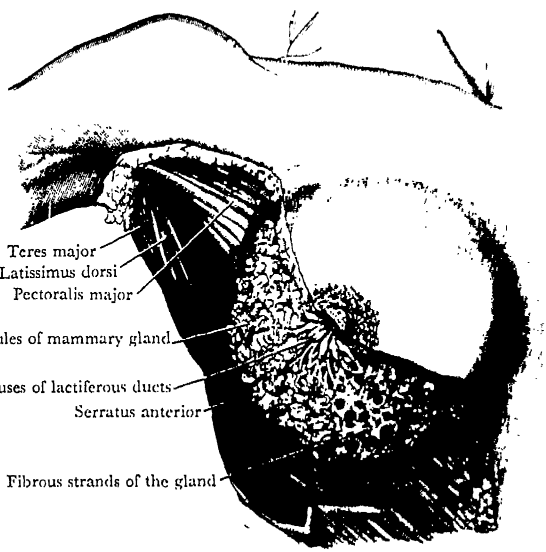


FIG. 6.—Dissection of Mammary Gland.

A little below its mid-point, and (unless it is pendulous) at a level which usually corresponds to the fourth intercostal space, the breast is surmounted by the *nipple*, which is placed in the middle of a circular patch of coloured skin known as the *areola of the breast*. There is no fat under the areola or in the nipple. A peculiar change of colour occurs in this region during the second month of a first pregnancy. At that time the delicate pink colour of the skin of the nipple and areola becomes converted to brown by the deposition of pigment; and it never again resumes its original appearance.

The base of the gland extends from the side of the sternum almost to the mid-axillary line, and from the second

rib to the sixth costal cartilage. About two-thirds of the gland is placed on the pectoralis major muscle, whilst the remaining part—its infero-lateral third—extends beyond the anterior fold of the axilla, and lies on the serratus anterior muscle and the external oblique muscle of the abdominal wall. From the part related to the lower border of the pectoralis major a prolongation extends upwards into the axilla—the "axillary tail" of the breast—and reaches as high as the third rib.

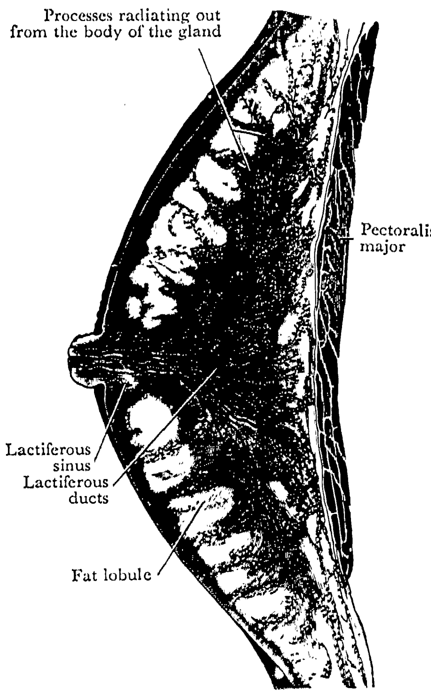


FIG. 7.—Section through a Mammary Gland prepared by the method recommended by the late Sir Harold Stiles.

The mammary gland has no capsule, and is not enclosed in a fascial sheath; in those respects it differs from many other glands. Its lobes and lobules are embedded in the superficial fascia between strands of fibrous tissue which pass through the superficial fascia from the skin to the deep fascia. The strands form the stroma or framework of the gland; and the mammary blood-vessels and some of its lymph-vessels enter and leave the gland along these strands. They support and bind together the various parts of the true glandular tissue, which consists of tubes lined with cells; and they attach the gland both to the skin and to the deep fascia.

The main body of the gland is composed of gland-tissue and stroma compactly arranged to form a wide-based conical

mass; but many processes of stroma and gland substance project from the surface and borders of the central mass; and the fat deposited in the hollows between the projections gives the breast its smooth, rounded contour.

The gland tubes, which secrete the milk, are grouped together into distinct *lobes*—fifteen to twenty in number—each subdivided into *lobules*, and all separated from one another by the fibrous stroma. The *lactiferous ducts*, one from each lobe, converge upon the nipple. Under the areola, each duct expands to form a *lactiferous sinus*, and, narrowing again, opens independently on the summit of the nipple (Figs. 6, 7).

In a well-injected body, twigs from the *intercostal arteries* and also from the *perforating branches of the internal mammary artery* may be traced into the mammary gland; and *mammary branches of the lateral thoracic artery* may be seen winding round the edge of the pectoralis major, or piercing its lower fibres, to reach the gland.

Lymph-Vessels of Mammary Gland.—The course of the lymph-vessels of the mamma and the widespread situations of its primary lymph-nodes are of the greatest importance in the spread of malignant growths and in determining the extent of tissue to be removed by the surgeon or the areas to be treated by the radio-therapist. The students should therefore study a text-book description of the lymph-drainage of the mamma after they have dissected the axilla, where most of the nodes are situated (Fig. 14). Some reference is made on p. 41 to the course of the main stream of lymph from the *subareolar lymph-plexus*.

Dissection.—Endeavour to make out some of the details described. Remove the fat from the surface of the gland, and define some of its lobes. Reflect the skin of the areola towards the nipple; if possible, pass a bristle into one of the ducts through its orifice on the nipple, and trace it to a lobe.

Next, gradually detach the gland from the deep fascia. Begin at the upper border, and, as the gland is displaced, note the strands of the stroma which connect its deep surface with the deep fascia. Trace the process that extends from the lateral margin of the gland into the axilla.

Finally, remove the gland by cutting the vessels at its margins; and then examine the deep fascia.

Deep Fascia.—The pectoral fascia is a thin membrane which closely invests the pectoralis major. It is attached above to the clavicle, and medially to the front of the sternum.

PLATE III

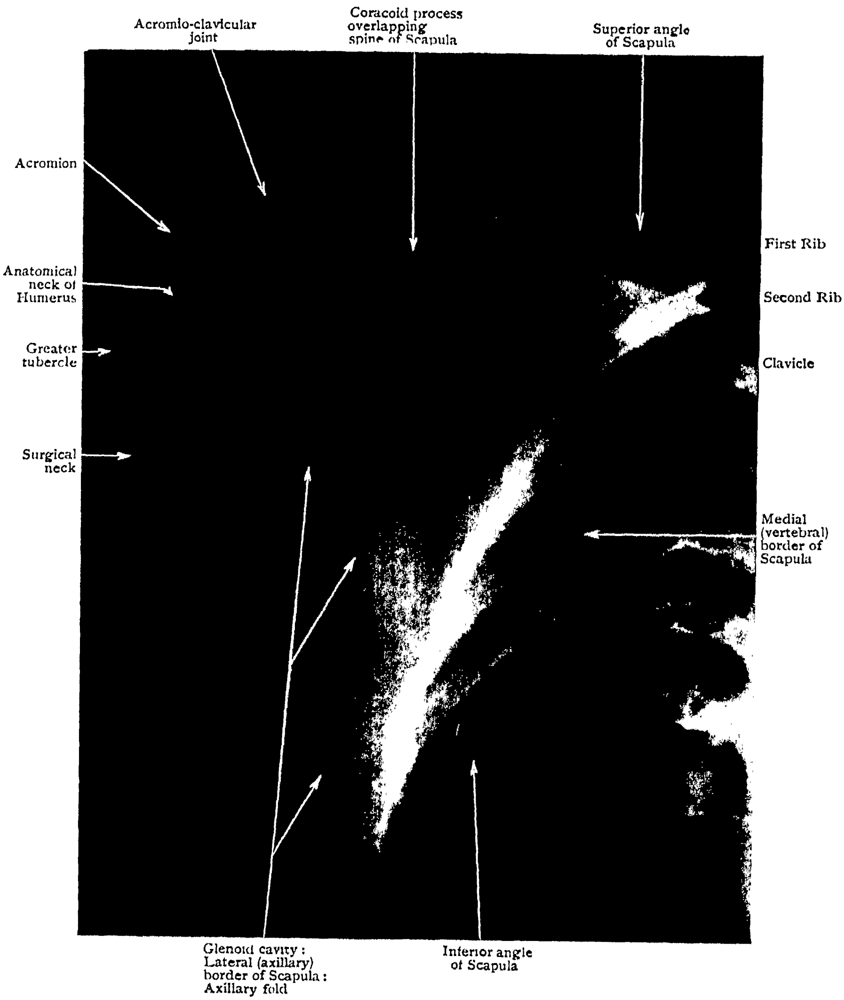


FIG. 8.—Radiograph of Shoulder Region of man aged 29.

PLATE IV

FIG. 9.—Radiograph of Shoulder Region of boy aged 7.

Note that the proximal epiphysis of the Humerus (formed by union of centres for head, greater (and sometimes lesser) tubercle) fits like a cap on end of shaft. Cf. Figs. 38 and 39.

Below, it is continuous with the deep fascia that covers the abdominal muscles ; and, at the lower border of the pectoralis major muscle, it is continuous with the axillary fascia. Laterally, it is continuous with the fascia that covers the deltoid muscle. At the infraclavicular fossa, a process from its deep surface dips in between the deltoid and pectoralis major muscles to join the clavi-pectoral fascia, a membrane that lies behind the clavicular portion of the pectoralis major and forms part of the deeper layer of the anterior wall of the axilla (p. 35).

The **axillary fascia** is a dense, felted membrane which extends across the base of the axilla and is continuous with the fasciæ of its walls. When the arm is raised, it is drawn up towards the hollow of the axilla, and the elevation is due chiefly to the connexion of its deep surface with the fascial sheath of the pectoralis minor.

Dissection.—Cut through the deep fascia along the groove between the pectoralis major and the deltoid, and display the *cephalic vein* (Figs. 32, 34) and the artery that accompanies it. Follow them upwards to the infraclavicular fossa, where they disappear under cover of the pectoralis major. As you clean the vein, look for a small *delto-pectoral lymph-node* that sometimes lies alongside it.

Next, clean the anterior part of the deltoid and the whole of the pectoralis major muscle.

Begin at the anterior border of the deltoid, and reflect the fascia until the base of the skin-flap is reached. As the fascia is reflected, look for small cutaneous nerves:—(1) *posterior supra-clavicular nerves* over the upper part of the deltoid ; (2) near the base of the skin flap, filaments of the *upper lateral cutaneous nerve of the arm* ; (3) other cutaneous twigs that pierce the anterior part of the deltoid (Figs. 32, 34).

To clean the pectoralis major : make the muscle tense by abducting the arm ; begin at one or other border, and reflect the fascia upwards or downwards.

Delto-Pectoral Lymph-Nodes.—These nodes—one or two —lie in the groove between the deltoid and the pectoralis major (Figs. 14, 30). They are placed in the path of the superficial lymph-vessels that run along the cephalic vein and convey lymph from the lateral side of the upper arm and shoulder and of part of the forearm, and transmit the lymph to the infraclavicular nodes, or direct to the apical nodes of the axilla (p. 41).

Pectoralis Major.—The pectoralis major is a powerful muscle that extends from the front of the thorax to the humerus. It is divided by a deep fissure into clavicular and

sterno-costal portions. The *clavicular portion* arises from the medial half of the front of the clavicle. The *sterno-costal portion* takes origin (1) from the anterior surface of the sternum, (2) from the upper six costal cartilages, and (3) from the aponeurosis of the external oblique muscle of the abdomen.

The muscle is inserted, by a flattened, bilaminar tendon, chiefly into the lateral lip of the intertubercular groove of the humerus.

The arrangement of the tendon and the muscle-fibres is peculiar. The tendon is folded on itself to form two laminæ, united along their lower borders and wholly blended together near the insertion. The clavicular head and upper sterno-costal fibres join the anterior lamina, the rest of the muscle the posterior lamina. But the several parts of the muscle are twisted as they approach the tendon, so that the clavicular

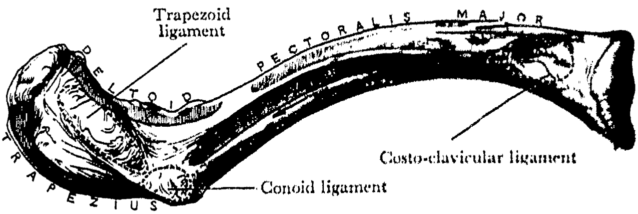


FIG. 10.—Lower Surface of Right Clavicle.

head forms the lowest part of the insertion and the lowest fibres of the muscle are inserted at the highest point on the humerus. The downward slant of the clavicular head and the upward curve of the lowest fibres give a concave, rounded contour to the lower border of the muscle, and, consequently, to the anterior fold of the axilla. In addition, the arrangement provides for separate, and even opposing, actions of the two heads of the muscle.

The pectoralis major is supplied by the *lateral* and *medial pectoral nerves*. As a whole, it is an adductor and a medial rotator of the upper limb; and, when the limb is thrust forwards or backwards by movements of the scapula, the pectoralis major assists in pulling it back again to the vertical position. The clavicular head, acting with the anterior fibres of the deltoid muscle (p. 85), is an active agent in flexion of the arm at the shoulder joint, a movement which can be reversed by the sterno-costal head.

AXILLA

The axilla is the hollow between the upper part of the side of the thorax and the upper part of the arm. When the

arm is abducted from the trunk, and the fatty tissue which occupies the axilla is removed, the space disclosed has the form of a four-sided pyramid. The apex is at the medial side of the coracoid process, and is directed upwards towards the root of the neck; the base of the space looks downwards. The medial wall is of greater extent than the lateral wall, and the anterior and posterior walls therefore converge as they approach the lateral wall. The posterior wall is longer, from above downwards, than the anterior wall, and the posterior border of the base is therefore lower than the anterior.

Before beginning the dissection of the space, examine its boundaries and the manner in which the contents are disposed in relation to the boundaries.

Boundaries and Contents of Axilla.—The four walls of the axilla are anterior, posterior, medial and lateral.

The *anterior wall* consists of the two pectoral muscles and a small muscle below the clavicle called the subclavius, and the fascia which encloses them. The pectoralis major forms the superficial stratum, and is spread out over the entire extent of the anterior wall. The pectoralis minor lies behind the middle third of the pectoralis major (Fig. 12); and the fascia between it and the clavicle is the *clavi-pectoral fascia*. The lower border of the anterior wall is the *anterior fold* of the axilla and is formed almost wholly by the pectoralis major.

The *posterior wall* of the axilla consists of (1) the lateral part of the subscapularis muscle, (2) a portion of the latissimus dorsi and its tendon, and (3) the teres major muscle. The subscapularis covers the costal surface of the scapula. The latissimus dorsi winds from the back round the lower border of the teres major to gain its anterior surface; thus, the lower border of the posterior wall—that is the *posterior fold* of the axilla—is formed in its medial part by the latissimus dorsi, and laterally by the teres major.

In the *medial wall*, there is part of the serratus anterior muscle and, deep to it, parts of the upper five ribs with the intervening intercostal muscles.

The *lateral wall* is formed by the humerus and the conjoined upper parts of the coraco-brachialis muscle and the short head of the biceps muscle.

The *apex* of the space leads up into the narrow, triangular passage through which the axilla communicates with the neck. The passage is bounded anteriorly by the clavicle, medially

by the outer border of the first rib, and posteriorly by the upper margin of the scapula; through it pass the axillary vessels and the big nerve-cords of the brachial plexus on

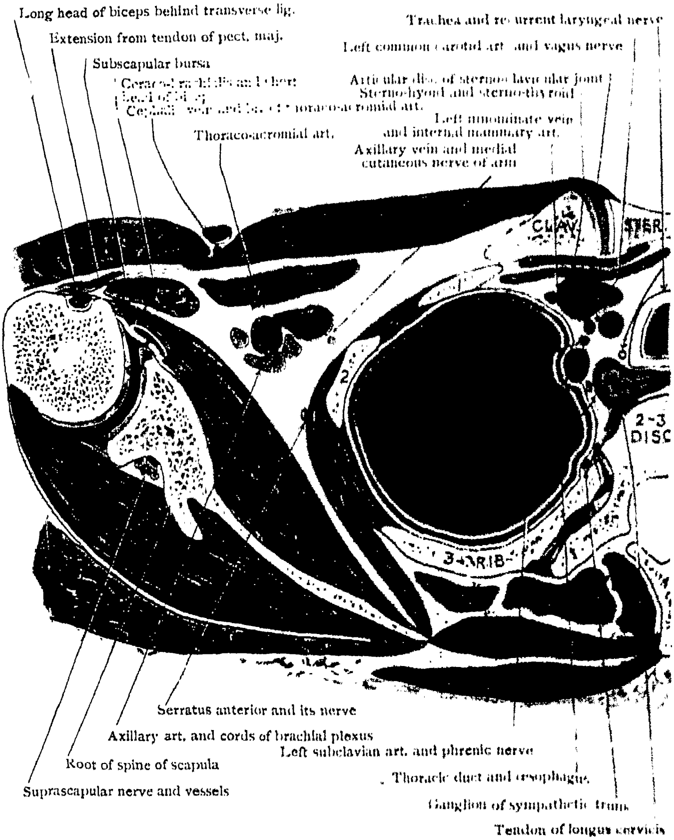


FIG. 11.—Horizontal Section at the level of Shoulder Joint (based on a section by Symington).

The chief structures in the Axilla and its Walls are shown, and also the chief relations of the Left Sterno-Clavicular Joint.

their way from the neck to the arm. Examine the boundaries of the passage from neck to axilla on the articulated skeleton.

The *base* or floor of the axilla is closed by the axillary fascia. The most important *contents* are the axillary artery and

vein, the large nerves of the upper limb, and the axillary lymph-nodes. They are all embedded in soft fat. In the lower part of the axilla, the great vessels and nerves lie close to the lateral wall, and follow it in all the movements of the arm.

Dissection.—Detach the clavicular head of the pectoralis major from the clavicle and scrape its area of origin clean. Turn the clavicular head towards the insertion, and, as you do so, secure the branches of the *lateral pectoral nerve* as they pass into the muscle ; trace them back to the *clavi-pectoral fascia*. Follow the *cephalic vein* to the point where it pierces that fascia. Clean the small arteries in this region ; they are branches of the *thoraco-acromial artery*, which also pierces the fascia. Clean the clavi-pectoral fascia and the fascia on the part of the pectoralis minor that has been exposed. Now, cut vertically through the pectoralis major about two inches from the sternum. Turn the medial part towards the median plane, and examine its attachments. Reflect the lateral part of the muscle towards the arm ; while doing that, secure the *medial pectoral nerve*, which perforates the pectoralis minor and ends in the pectoralis major. Clean the fascia that covers the remainder of the pectoralis minor. Reflect the pectoralis major fully, leaving a tag of muscle attached to the ends of its nerves ; clean its tendon, and examine its insertion.

Complete reflexion of the pectoralis major exposes a thick, continuous sheet of fascia, which extends from the clavicle to the axillary fascia and from the wall of the thorax to the arm. It is because of the attachment of that fascial sheet to the clavicle above and to the axillary fascia below that the floor of the axilla is raised as the arm is abducted from the side and the clavicle is elevated. The pectoralis minor muscle, passing obliquely from its origin on the thoracic wall to its insertion into the coracoid process of the scapula, runs through the substance of the sheet and divides it into three parts :—(1) The middle part encloses the muscle. (2) The lower part, as it extends downwards to blend with the axillary fascia, covers the lower parts of the axillary vessels and nerves. (3) The upper part is the clavi-pectoral fascia.

Clavi-Pectoral Fascia.—This fascia occupies the gap between the clavicle and the pectoralis minor, and extends from the first rib medially to the coracoid process laterally. Its upper part is split into two layers, an anterior and a posterior, which are attached to the clavicle, and enclose the *subclavius* between them. The strongest part of the membrane is that which extends along the lower border of the subclavius, from the first rib to the coracoid process. The membrane is continuous below with the fascial sheath of the pectoralis minor, and is connected posteriorly with the fascial sheath of the axillary vessels (Fig. 12). It is perforated by the cephalic vein, the thoraco-acromial artery, and the

lateral pectoral nerve. Note (1) *that the fibres of the membrane run medio-laterally*, (2) *that they are put on the stretch when the arm is abducted*, and (3) *that they are relaxed when the arm is by the side.* The surgeon takes advantage of these facts when he is ligaturing the first part of the axillary artery.

> **Dissection.**—Cut through the anterior layer of the upper part of the clavi-pectoral fascia, expose the *subclavius muscle* and examine the attachments of the fascia to the clavicle; and then carefully remove the whole of the fascia.
>
> Follow the *cephalic vein* to its junction with the axillary vein, and the *thoraco-acromial artery* and *lateral pectoral nerve* to their origins. Clean the proximal parts of the *axillary artery* and vein and the nerve-cord from which the pectoral nerve springs. Find the small *communicating nerve* that connects the two pectoral nerves and crosses the axillary artery.
>
> Clean the *pectoralis minor* muscle, without injuring the medial pectoral nerve, which pierces it.

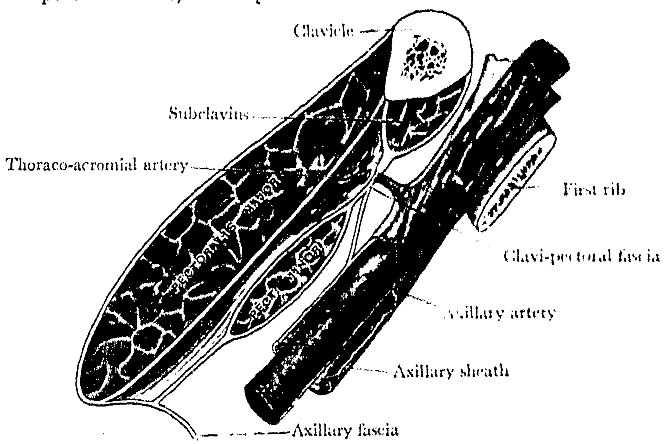


FIG. 12.—Diagram of Clavi-Pectoral Fascia.

Pectoralis Minor.—This is a triangular muscle which arises from the third, fourth and fifth ribs, close to their cartilages. Its fibres pass upwards and laterally, and its tendon of insertion is attached to the medial border and the upper surface of the coracoid process, near its tip.

When the muscle is in action it draws the scapula downwards and forwards, and depresses the shoulder. It is supplied by the *medial pectoral nerve.* The greater portion of the pectoralis minor is concealed by the pectoralis major, but the lower part of its infero-lateral border appears on the side of the thorax below the pectoralis major; its insertion is concealed by the anterior fibres of the deltoid.

Dissection.—Throughout the dissection of the axilla, look for the *lymph-nodes* and note their positions ; they lie mainly along the lines of the blood-vessels. If they are healthy they are very small, and are inconspicuous among the fat.

Clear away the fascia below the level of the pectoralis minor and open up the lower part of the axilla ; remove also the deep fascia in the region of the lateral boundary of the axilla.

Begin below the lateral part of the pectoralis minor and clean the *coraco-brachialis* and the *short head of the biceps*, as they descend from the coracoid process. Find the axillary artery at the medial border of the coraco-brachialis. The trunk of the *median nerve* lies between the artery and the muscle, and the medial root of the nerve crosses in front of the artery. Pull the coraco-brachialis laterally and find the *musculo-cutaneous nerve* entering its deep surface. A little higher up, look for the branch of the musculo-cutaneous nerve that enters the coraco-brachialis to supply it.

Look in the interval between the axillary artery and vein, and find a long slender nerve called the *medial cutaneous nerve of the forearm*, and, behind it, a thicker nerve—the *ulnar*.

Another slender nerve, the *medial cutaneous nerve of the arm*, runs along the medial side of the axillary vein. Secure it, and follow it upwards to the point where it receives a communicating branch from the *intercosto-brachial nerve*, which runs across the axilla. Follow the intercosto-brachial nerve to the point where it emerges from the second intercostal space, and laterally to the arm, where it is distributed.

Turn now to the medial wall of the axilla, and find the anterior and posterior branches of the *lateral cutaneous nerves* as they emerge between the digitations of the serratus anterior behind the lower border of the pectoralis minor. Trace them forwards and backwards. Clean the *lateral thoracic artery* as it runs downwards along the border of the pectoralis minor. Secure the *nerve to the serratus anterior* as it descends over the surface of that muscle, and then clean the muscle.

Lateral Cutaneous Branches of Intercostal Nerves.—These nerves emerge from the spaces between the ribs, and divide into anterior and posterior branches under cover of the serratus anterior muscle ; and these branches pierce the muscle or appear between its digitations. The *anterior branches* appear, as a rule, about an inch in front of the corresponding posterior branches, and then pass forwards over the lower border of the pectoralis major muscle. From the lower members of this series some minute twigs are given to the external oblique muscle of the abdomen, which will be exposed by the dissectors of the Abdomen. The *posterior branches* run backwards over the latissimus dorsi muscle (Fig. 13).

The lateral cutaneous branch of the first intercostal nerve, though said to be constant (Cave), is seldom found. The

lateral branch of the second nerve is the largest of the series, and differs from the others in not dividing into an anterior and a posterior branch. It is termed the *intercosto-brachial*

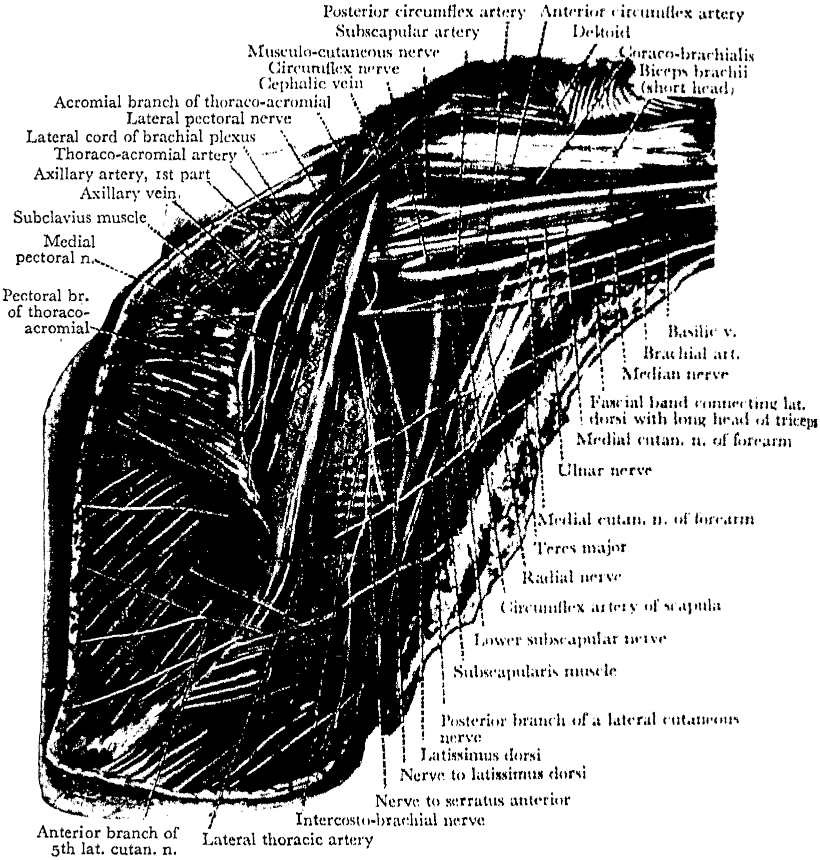


FIG. 13.—Contents of Axilla exposed by Reflexion of Pectoralis Major and the Fascia, and Removal of Fat and Lymph-Nodes. Part of Axillary Vein has been removed to display the Medial Cutaneous Nerve of Fore-arm and Ulnar Nerve.

nerve, on account of its being distributed to the skin of the upper arm. To reach this destination it crosses the axilla and pierces the deep fascia of the arm a little below the posterior fold of the axilla. But before piercing the fascia it

establishes communications with the medial cutaneous nerve of the arm and the lateral cutaneous branch of the third intercostal nerve. Branches from the plexus so formed supply the skin of the floor of the axilla.

The *lateral cutaneous branch* of the third intercostal nerve divides into an anterior and posterior part, which are distributed in the ordinary way, except that the posterior branch sends twigs to the skin of the floor of the axilla and of the upper part of the medial side of the arm.

Dissection.—Clean the lower parts of the large vessels and nerves and their branches and tributaries.

With chain and hooks, pull the axillary artery and the medial cutaneous nerve of the forearm towards the arm ; displace the axillary vein in the opposite direction ; identify the ulnar nerve again, and look for a slender contribution which it occasionally receives from the lateral cord of the brachial plexus (p. 99). Look also for a thick nerve which lies behind the axillary artery. That is the *radial nerve* ; pull it medially ; follow its lateral border upwards ; and, at the lower border of the subscapularis muscle, find a medium-sized nerve, the *circumflex nerve*, which bends backwards into the posterior wall of the axilla.

Near the circumflex nerve, find a large vessel, the *subscapular artery*, and clean it. Follow it first towards its origin from the axillary artery, and find a large branch, the *circumflex scapular artery*, which springs from it and turns backwards into the posterior wall of the axilla. Follow it next downwards and backwards, taking care not to injure the intercosto-brachial nerve and the posterior branches of the 3rd, 4th and 5th lateral cutaneous nerves, as they cross in front of the artery. Near its lower end, secure the *nerve to latissimus dorsi*, which crosses in front of the artery. Return to the angle between the subscapular artery and its circumflex branch ; secure the *lower subscapular nerve*, and trace it into the teres major muscle.

Return to the radial nerve at the lower margin of the subscapularis muscle, and look for the branches that spring from the nerve near that point. They are the *posterior cutaneous nerve of the arm* and *muscular branches* to the long and medial heads of the triceps muscle. They may arise separately or by a common stem. Trace them downwards.

The lateral thoracic and the subscapular branches of the axillary artery have now been found. Return to the axillary artery ; find its other branches, and clean them.

After the lower part of the axilla has been thoroughly cleaned, divide the pectoralis minor midway between its origin and insertion, and turn the two parts aside. Secure the *upper subscapular nerve* as it enters the upper part of the subscapularis ; and then clean the contents of the upper part of the axilla thoroughly.

When the dissection has been completed, the contents of the space must be studied in detail.

Axillary Lymph-Nodes. — The lymph-nodes in the axillary region are spoken of, collectively, as the axillary

nodes, but for convenience of description in relation to the areas they drain, they are divided into several subordinate groups. Some of the nodes have been removed as the dissection proceeded, and others are so small that they may have escaped the attention of the dissectors ; but, during the

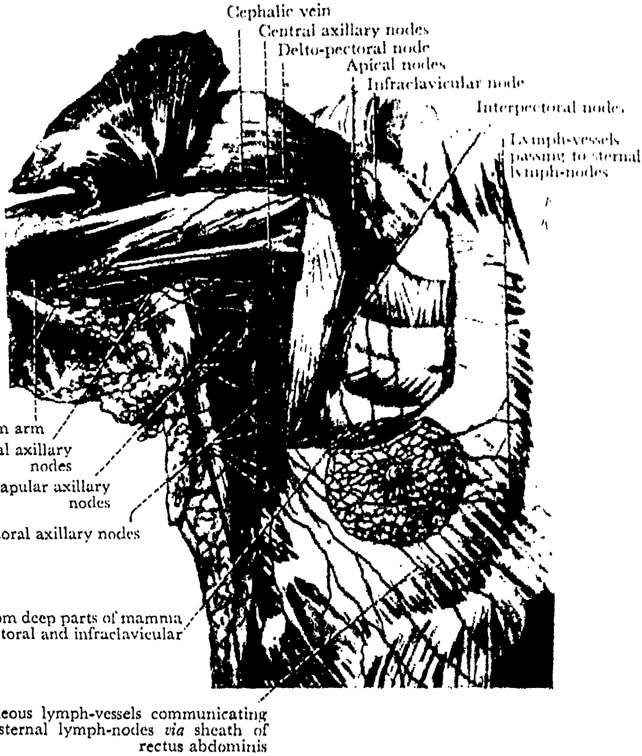


FIG. 14.—Lymph-Nodes and Lymph-Vessels of Axilla and Mamma.

course of the dissection of the armpit, three main groups of nodes will have been noted :—(1) A lateral or **brachial group** of six or more nodes which lie along the axillary vessels ; they receive the lymph-vessels from the greater part of the upper limb. (2) An anterior or **pectoral group** which lies in the angle between the anterior and medial walls of the axilla and is subdivided into upper and lower parts. Two or three upper pectoral nodes lie behind the pectoralis major in the

region of the second and third intercostal spaces, and receive the main stream of lymph from the mammary gland through the subareolar lymph-plexus (Fig. 14); the lower pectoral nodes lie along the lateral thoracic vessels, and receive lymph from the side of the thorax. (3) A posterior or **subscapular group** which lies along the subscapular vessels on the posterior wall of the axilla, and receives lymph-vessels mainly from the back.

The lymph-nodes in the axilla drain a wide territory apart from the free upper limb—the pectoral region and the abdominal wall down to the level of the umbilicus, the side of the chest, the scapular region and the back down to the iliac crest. The regions above that territory are drained into the lymph-nodes of the neck, and the regions below into the nodes of the groin—to which also there is a convergence of superficial lymph-vessels from a wide area.

In addition to the lymph-nodes which are usually seen in an ordinary dissection, there are three other groups of nodes :—(*a*) The *central nodes*, which are very variable; they lie either on the surface of the axillary fascia, in a pocket of its substance, or deep to it in the fat of the middle part of the axilla; they have no afferents from any definite region, but connect the other groups together. (*b*) The *infraclavicular nodes*, which lie on the clavi-pectoral fascia in the infraclavicular fossa. One or two in number, they are associated with other nodes in two outlying situations—a few *interpectoral nodes* on the anterior surface of the pectoralis minor, which receive lymph from the deep part of the mammary gland by lymph-vessels which pierce the pectoralis major, and the *delto-pectoral nodes* (p. 31)—and discharge into the next group. (*c*) The *apical nodes*, which lie in the apex of the axilla behind the clavi-pectoral fascia. They receive efferents from all the other groups; and their own efferents unite to form a vessel called the *subclavian lymph-trunk*, which terminates usually in the subclavian vein.

Axillary Artery.—The axillary artery is the chief artery of the upper limb. It begins, as a continuation of the subclavian artery, at the outer border of the first rib, enters the axilla through its apex, and runs along the lateral wall to the lower border of the teres major. There it leaves the axilla and becomes the brachial artery. The direction which the artery takes naturally varies with the position of the limb.

For convenience of description, the axillary artery is usually divided into three parts—the part above the pectoralis minor, the part behind it, and the part below it. They are known respectively as the first, second and third parts. The three thick cords that form the lower part of the brachial plexus are closely related to the first and second parts of the artery; and the large nerves that spring from the cords are grouped round the third part.

The first part of the axillary artery lies very deeply, behind the clavicular part of the pectoralis major, the clavi-pectoral fascia and the vessels and nerves superficial to it. Even when these are removed the vessel is not completely exposed, because it is enveloped, along with the axillary vein and brachial plexus, in a funnel-shaped sheath which is prolonged over

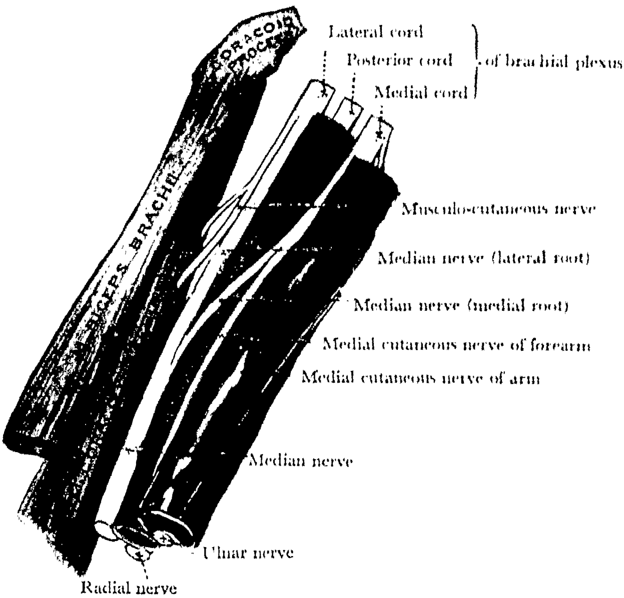


FIG. 15.—Diagram to show Relations of Axillary Vessels and Nerves.

them from the deep fascia of the neck (Fig. 12). *Posteriorly*, it is separated from the first intercostal space and the first digitation of the serratus anterior by the nerve to that muscle and the medial cord of the brachial plexus. The axillary vein is on its *medial side*, and overlaps its anterior surface slightly; *above* and to its *lateral side* there are the lateral and posterior cords of the brachial plexus.

The second part is placed behind the two pectoral muscles, and has the three cords of the brachial plexus disposed around it. The axillary vein is still medial to it, but is separated by the medial cord.

The **third part** is the longest part. It is superficial in its lower half, because the anterior wall of the axilla does not extend so far down as the posterior. The upper half of the third part is covered by the pectoralis major but its lower half by the skin and fasciæ only. The medial root of the median nerve crosses in front of it at the lower border of the pectoralis minor. The circumflex nerve and the radial nerve lie between it and the posterior wall of the axilla. The coraco-brachialis muscle is on its *lateral* side, and also the median and musculo-cutaneous nerves, which lie between the muscle and the artery. The axillary vein is on the *medial* side of the artery, with the medial cutaneous nerve of the forearm and the ulnar nerve between the artery and vein. More medially still, the medial cutaneous nerve of the arm lies along the medial side of the vein (Fig. 15).

Branches.—The branches of the axillary artery have been seen at different stages of the dissection. They should now be examined more fully (Fig. 16).

The **superior thoracic artery** is a small branch that ramifies on the upper part of the medial wall of the axilla (Fig. 16).

The **thoraco-acromial artery** is a short, wide trunk which takes origin under cover of the pectoralis minor. It winds round the upper border of that muscle, pierces the clavi-pectoral fascia, and immediately divides into four small branches which diverge from one another and supply neighbouring structures; the largest of them runs downwards between the pectoral muscles. The *veins* that accompany those branches end in the cephalic vein.

The **lateral thoracic artery**, skirting the lower border of the pectoralis minor, proceeds downwards and medially to the side of the thorax. In the female, it is an important source of supply to the lateral part of the mammary gland.

The **subscapular artery** is the largest branch of the axillary. It runs downwards and backwards along the lower border of the subscapularis to the inferior angle of the scapula, giving off muscular branches. Note that it ends by entering the latissimus dorsi with the nerve to that muscle (Fig. 20)—a notable example of a neuro-vascular hilum (p. 12). Its largest branch is the *circumflex scapular artery* (Fig. 16), which springs from it an inch below its origin, and takes a large share in the anastomosis around the scapula.

The two circumflex humeral arteries arise at the same level —a short distance below the subscapular artery.

The **posterior circumflex humeral artery** is much the larger of the two. Only a small portion of it can be seen at the present stage. It springs from the back of the axillary artery, and at once passes backwards, with the circumflex

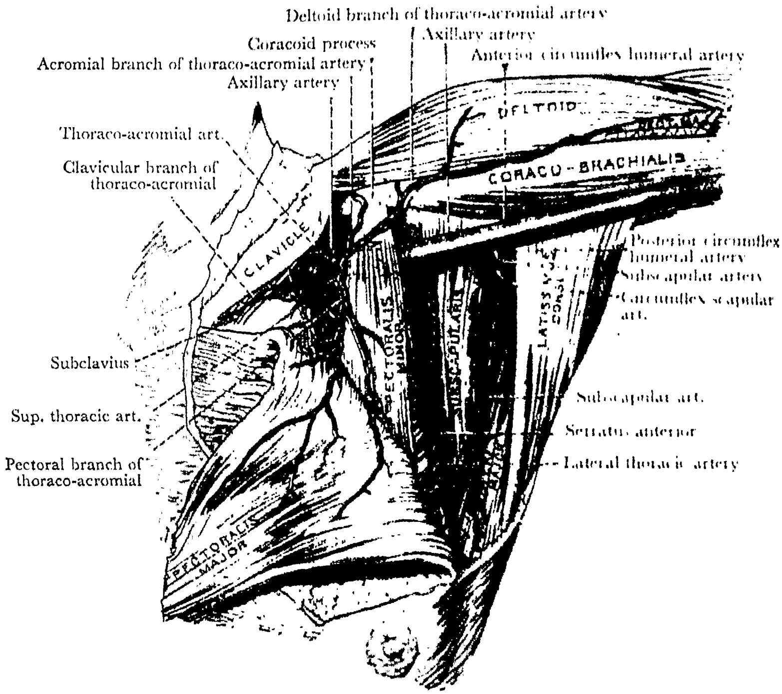


FIG. 16.—Dissection of Axillary Artery and its Branches.

nerve, in the interval between the subscapularis and teres major muscles on the medial side of the surgical neck of the humerus, below the shoulder joint; and, curving round the surgical neck, under cover of the deltoid muscle, it is spent chiefly in supplying that muscle.

The **anterior circumflex humeral artery** runs laterally, in front of the surgical neck of the humerus, under cover of the coraco-brachialis and short head of the biceps brachii.

Reaching the bicipital groove, it divides into two branches, one of which runs up to the shoulder joint, while the other anastomoses with twigs of the posterior circumflex artery.

Axillary Vein.—This vessel has the same extent as the artery. It begins at the lower border of the teres major as the continuation of the basilic vein, and it becomes the subclavian vein at the outer margin of the first rib. It lies along the medial side of the axillary artery, overlapping it

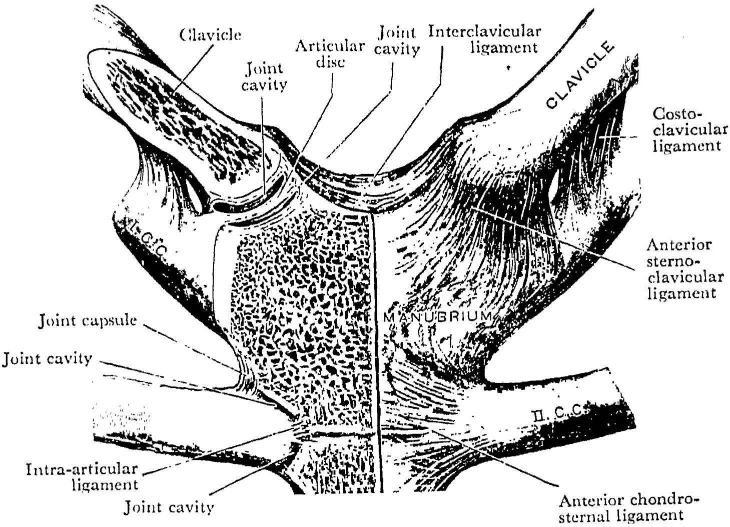


FIG. 17.—Sterno-Clavicular and Costo-Sternal Joints.

anteriorly; and as the arm is abducted from the side the vein passes more and more in front of the artery.

At the lower margin of the subscapularis, it receives the two *venæ comitantes* of the brachial artery; and above the level of the pectoralis minor it is joined by the cephalic vein.

Subclavius.—This small muscle lies immediately below the clavicle, enclosed between the two layers of the clavi-pectoral fascia. It takes origin, by a short, rounded tendon, from the upper surface of the first costal arch, at the junction of the bone with the cartilage; and the fleshy belly is inserted into the floor of the shallow groove on the lower surface of the clavicle. The nerve of supply is derived from the fifth and

sixth cervical nerves and enters the posterior surface of the muscle. The subclavius helps to steady the clavicle in movements of the shoulder-girdle.

Dissection.—When the subclavius has been examined, divide it horizontally, in order to find the costo-clavicular ligament, which lies behind its medial end.

At this stage, examine the *sterno-clavicular joint* with the aid of the dissectors of the Neck. Detach the clavicular head of the sterno-mastoid from the clavicle, and pull the sternal head of the muscle towards the median plane in order to expose the upper and anterior surfaces of the joint.

Sterno-Clavicular Joint.—This is a synovial joint at which the medial end of the clavicle fits into the shallow socket provided by the clavicular notch of the manubrium sterni and the upper surface of the first costal cartilage. It is the only point of articulation of the upper limb with the axial skeleton and it determines the range of its movements. The joint is enclosed in an articular capsule attached to the cartilage and the bones just beyond the margins of the articular surfaces. The anterior and posterior parts of the **fibrous capsule** are very strong and are called the **anterior** and **posterior sterno-clavicular ligaments.** Associated with the joint there are an articular disc and two accessory ligaments —the interclavicular and the costo-clavicular.

The **articular disc** is a nearly circular plate of fibrocartilage situated in the interior of the joint, which it divides into two separate *synovial cavities*. It is continuous with the anterior and posterior ligaments, but its main attachments are to the upper part of the medial end of the clavicle, and to the sternum and first costal cartilage at their junction; it therefore acts as a ligament which prevents upward displacement of the sternal end of the clavicle.

The **interclavicular ligament** is fused with the upper part of the capsular ligament. It passes between the medial ends of the two clavicles, but dips down to be attached also to the upper border of the manubrium.

The **costo-clavicular ligament** is a strong, thick, flattened band that lies behind the subclavius muscle. It is attached to the first rib and its cartilage at their junction, and extends upwards and laterally to a rough impression on the lower surface of the clavicle near its medial end.

Behind the joint there are two ribbon-like muscles of the neck—the *sterno-hyoid* and the *sterno-thyroid*. They separate

the right joint from a large artery called the *innominate*, and the left joint from the *left innominate vein* (Fig. 11).

Dissection.—Cut through the anterior part of the capsule of the joint close to the sternum. Identify the *sterno-hyoid* and *sterno-thyroid* muscles in the root of the neck just above the joint, and a small vein, called the *anterior jugular*, that runs laterally in front of them. Push the vein out of the way, and detach the fibres of the sterno-hyoid that arise from the posterior ligament. Push the knife down behind the joint, cut the posterior ligament, and pull the clavicle laterally.

The articular disc is now exposed. Examine its attachments. Detach it from the costal cartilage ; then, carry the knife laterally below the clavicle and cut through the lower part of the capsule and the costo-clavicular ligament. Displace the clavicle upwards and laterally to bring the whole of the brachial plexus into view.

Brachial Plexus.—This important plexus is formed by the ventral rami of the lower four cervical nerves and the greater part of the ventral ramus of the first thoracic nerve. The plexus is reinforced, above, by a small twig of communication which passes from the fourth cervical nerve to the fifth, and, below, by a similar connecting twig that passes upwards, in front of the neck of the second rib, from the second thoracic nerve to the first.

The manner in which the nerves join to form the plexus is very constant. The *fifth* and *sixth cervical nerves* unite to form an upper trunk ; the *seventh* remains single and proceeds laterally as a middle trunk ; whilst the *eighth* and *first thoracic nerves* join to form the lower trunk. A short distance above the clavicle each of the three trunks splits into an *anterior* and a *posterior division*. When the three anterior divisions are raised on the handle of a knife, it will be seen that the three posterior divisions unite to form the posterior cord of the plexus and that the lowest or most medial of the posterior divisions is much smaller than the other two. Of the three anterior divisions, the *two upper* unite to form the lateral cord of the plexus, and the *lower* passes distally by itself as the medial cord. The three cords give off most of the branches that supply the upper limb (Figs. 18, 20).

The plexus may be divided, therefore, into four stages :—

First Stage . .	Five separate nerves (viz., lower four cervical and first thoracic).
Second Stage .	Three trunks (viz., upper, middle and lower).
Third Stage .	Three anterior divisions and three posterior divisions.
Fourth Stage .	Three cords (viz., lateral, medial and posterior).

The plexus begins at the lateral border of the *scalenus anterior* muscle in the neck, behind the lower third of the

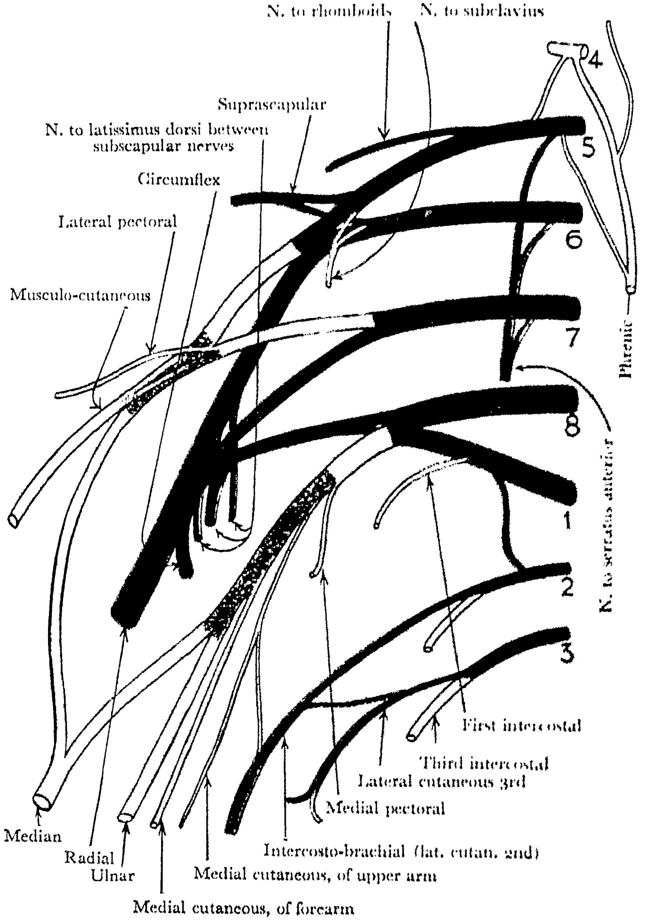


FIG. 18.—Diagram of Right Brachial Plexus.

Ventral offsets, yellow; dorsal offsets, green. For the principle of the formation and distribution of the plexus (p. 49), cf. the arrangement of the lumbo-sacral plexus, Figs. 103, p. 201 and 119, p. 240.

posterior border of the sterno-mastoid. It passes through the lower part of the posterior triangle of the neck, and behind the middle third of the clavicle, into the upper part of the

axilla; and it ends behind the lower border of the pectoralis minor near the coracoid process, where it breaks up into the large nerves of the upper limb. Its termination is therefore at the junction of the second and third parts of the axillary artery; consequently, the first and second parts of the artery are related to the cords of the plexus, and the third part is related to the large nerves that spring from them.

As a rough guide to their position, it may be stated that the first two stages are in the neck, the third stage is behind

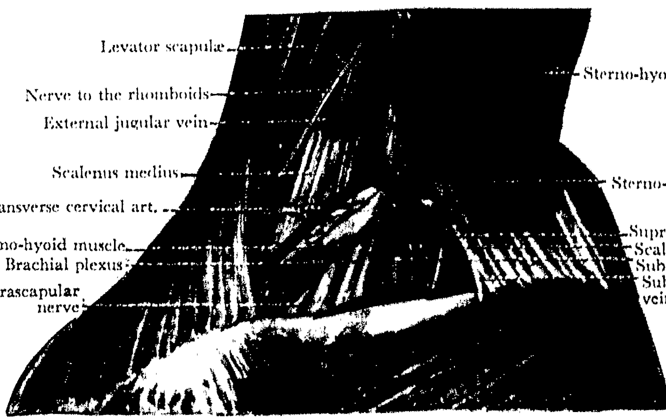


FIG. 19.—Dissection of lower part of Posterior Triangle of Neck. Showing the Supraclavicular Part of Brachial Plexus. For the supraclavicular branches of the Cervical Plexus, see Fig. 8, p. 27.

the clavicle, and the last stage is in the axilla (Figs. 19, 20). The study of the plexus should therefore be undertaken jointly by the dissectors of the Upper Limb and of the Head and Neck.

The branches of the plexus spring from its roots and from its cords; and it should be noted that four of the nerves that arise in the neck supply muscles of the limb. The dissectors should understand that there is a principle underlying the splitting of the three trunks into anterior and posterior divisions: these are distributed, through the cords which they form, to the ventral or flexor and the dorsal or extensor regions of the limb respectively, with some overlapping in the case of cutaneous nerves. The same principle applies to the formation and distribution of the Lumbo-Sacral Plexus for the supply of the Lower Limb, as seen in Figs. 103 and 1.9 and more fully described in Vol. II.

Branches of Brachial Plexus.—The following branches *arise in the neck and are distributed in the upper limb.*

The **nerve to the rhomboids** (C. 5) runs downwards and

laterally a little above the brachial plexus, disappears among muscles, and will be encountered again when the back is dissected.

The **suprascapular nerve** (C. 5, 6) runs laterally and downwards immediately above the plexus, disappears under the trapezius muscle, and will be further dissected in the scapular region.

The **nerve to subclavius** (C. 5, 6) descends in front of the plexus to enter the back of the subclavius muscle.

The **nerve to serratus anterior** (C. 5, 6, 7) runs most of its course in the axilla. It arises by three separate roots, which descend behind the cervical part of the brachial plexus, and are therefore concealed by it. The upper two roots unite to form one stem which enters the axilla by crossing the first digitation of the serratus anterior behind the first part of the axillary artery, and gives twigs to the upper part of the muscle. The lower root descends close by that stem and joins it in the axilla. The nerve then runs downwards over the surface of the serratus anterior, about the junction of the anterior and middle thirds of the medial wall of the axilla, giving off twigs to each of its digitations.

The following table shows the *branches from the cords* with their " root-values ", *i.e.*, the spinal nerves from which their fibres are usually derived.

From the lateral cord :

Lateral pectoral (C. 5, 6, 7).
Musculo-cutaneous (C. 5, 6, 7).
Lateral root of median (C. 5, 6, 7).

From the medial cord :

Medial pectoral (C. 8, T. 1).
Medial cutaneous of forearm (C. 8, T. 1).
Medial cutaneous of arm (T. 1, 2).
Medial root of median (C. 8, T. 1).
Ulnar (C. 7, 8, T. 1).

From the posterior cord :

Upper and Lower Subscapular (C. 5, 6).
N. to latissimus dorsi (C. 6, 7, 8).
Circumflex (C. 5, 6).
Radial (C. 5, 6, 7, 8, T. 1).

Pectoral Nerves.—These two nerves, which pass forwards on the lateral and medial sides of the first part of the axillary

artery and communicate in front of it, are the nerves of supply to the pectoral muscles.

The *lateral pectoral nerve* (C. 5, 6, 7) springs from the lateral cord, pierces the clavi-pectoral fascia, and breaks up into branches which enter the deep surface of the pectoralis major.

The *medial pectoral nerve* (C. 8, T. 1) is smaller than the lateral. It springs from the medial cord, gives twigs of

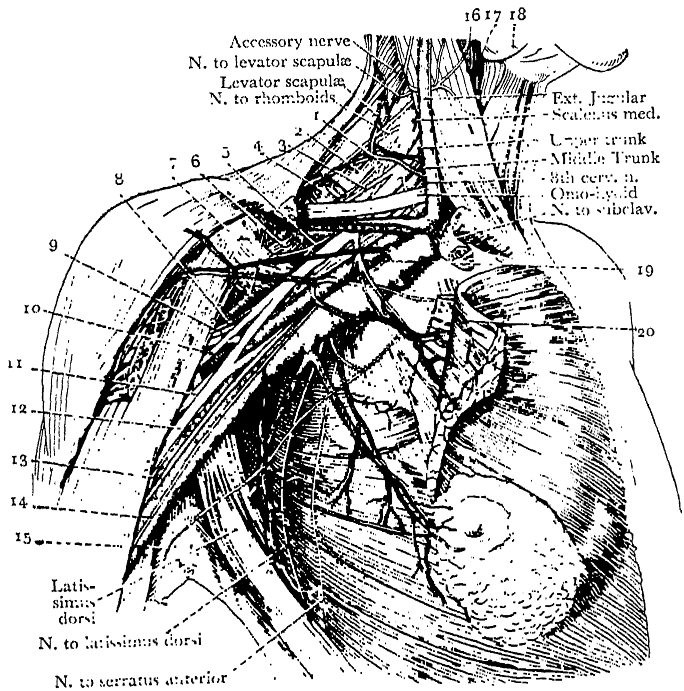


FIG. 20.—Dissection to show General Relations of Brachial Plexus.

1. Nerve to serratus anterior.
2. Scalenus medius.
3. Suprascapular nerve.
4. Serratus anterior.
5. Upper subscapular nerve.
6. Subscapularis.
7. Pectoralis minor.
8. Nerve to coraco-brachialis.
9. Circumflex nerve.
10. Musculo-cutaneous nerve.
11. Radial nerve.
12. Median nerve.
13. Medial cutaneous nerve of forearm.
14. Medial cutaneous nerve of arm.
15. Intercosto-brachial nerve.
16. Internal jugular vein.
17. Superior thyroid artery.
18. Submandibular gland.
19. Lateral pectoral nerve.
20. [illegible]

supply to the pectoralis minor, then pierces that muscle and ends in the pectoralis major.

The pectoralis major is thus supplied by both pectoral nerves, the pectoralis minor by the medial nerve alone.

Subscapular Nerves.—The subscapular nerves (C. 5, 6) are two in number—the *upper* and the *lower*. They spring from the posterior cord of the plexus. After a very short course the upper nerve sinks into and supplies the upper and posterior part of the subscapularis. The lower subscapular nerve passes downwards and laterally, gives branches to the lower part of the subscapularis, and ends in the teres major, which it supplies.

Nerve to Latissimus Dorsi.—This nerve (C. 6, 7, 8) springs from the posterior cord between the two subscapular nerves, passes obliquely downwards and laterally through the axilla, and crosses in front of the subscapular artery to enter the deep surface of the latissimus dorsi at the inferior angle of the scapula. It is accompanied into the muscle by the terminal branch of the subscapular artery (p. 43) at a very obvious neuro-vascular hilum.

The other branches which spring from the cords will be described later.

Serratus Anterior.—This large and powerful muscle arises by fleshy digitations from the upper eight ribs about midway between their angles and cartilages. The slips are arranged on the chest wall so as to present a gentle curve convex forwards. The lower three interdigitate with the external oblique muscle of the abdomen. The serratus anterior is inserted into the entire length of the medial margin of the scapula (Fig. 22), and it falls naturally into three parts (Fig. 21). The scapular attachments will be more fully examined when the subscapularis muscle is dissected (p. 90).

(*a*) The *upper part* is composed of the first digitation, which is the largest of the series. It arises from the first and second ribs and from a tendinous arch between them; and its fibres converge to be inserted into a triangular area on the costal surface of the upper angle of the scapula. (*b*) The *middle part* consists of the two digitations from the second and third ribs, and its fibres spread out to be inserted into the anterior lip of the medial margin of the scapula. (*c*) The *lower part* is composed of the remaining digitations of the

muscle. They converge to form a thick mass which is inserted into a rough area on the costal surface of the inferior angle of the scapula.

The deep surface of the serratus anterior is in contact with the chest wall.

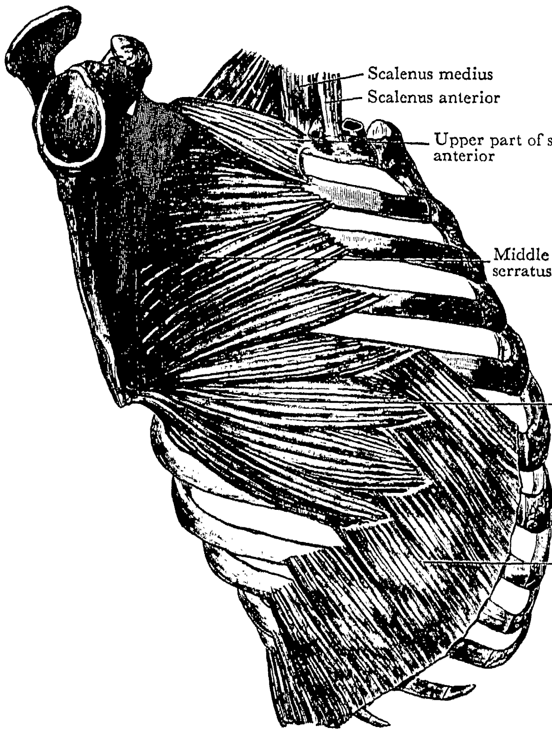


FIG. 21.—Serratus Anterior Muscle and origin of External Oblique Muscle. The scapula is drawn away from the side of the chest.

It is the most powerful protractor of the whole upper limb, and it assists in the rotation of the scapula that accompanies the raising of the arm above the head. Its usual action may be reversed so that, acting from the scapula, it raises the ribs in forced inspiration. It is supplied by the special nerve from the fifth, sixth, and seventh cervical nerves (p. 50).

Care of Dissection.—At the end of the fifth day, after the dissectors have examined the serratus anterior and carefully

revised the contents of the axilla, they must replace the clavicle, pack the axilla with tow or rags soaked in preservative fluid, and fix the skin-flaps to the wall of the thorax with a few stitches.

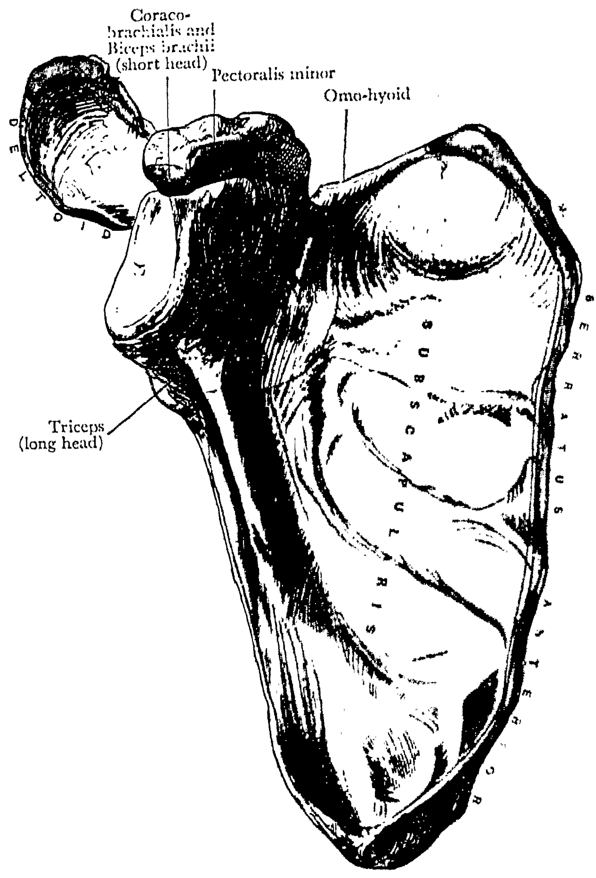


FIG. 22.—Costal aspect of Scapula with Attachments of Muscles mapped out.

DISSECTION OF THE BACK

When the dissectors return on the sixth day they will find that the body has been placed face downwards, with blocks supporting the chest and the pelvis. It will remain in that position for five days, and during the first two of those the

dissectors of the Upper Limb will examine the structures which connect the limb with the back of the trunk.

This dissection should be completed and the limb removed

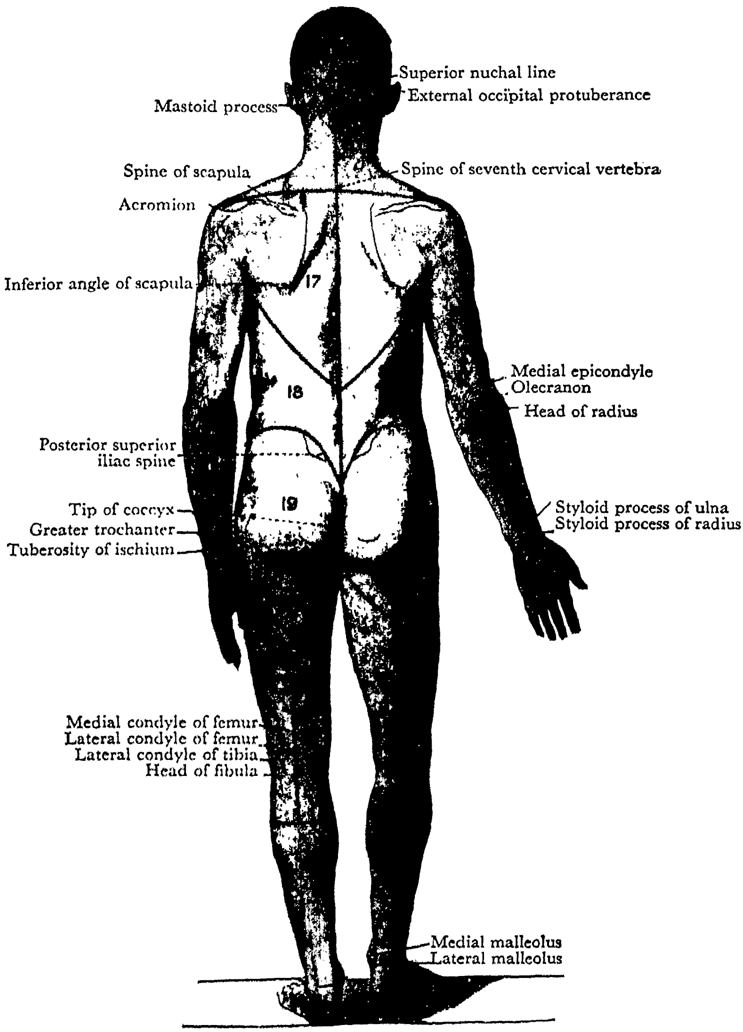


FIG. 23.—Landmarks and Incisions. For the bony landmarks of the Upper Limb, cf. Fig. 2, Pl. I, and the radiographs in other Plates.

of the vertebræ are felt in the furrow: pass the finger over them. Note that their tips do not all lie in the median line: some are deflected to one side or the other. The spines are the only parts of the vertebral column that are subcutaneous or easily felt, but it is very seldom possible to identify individual spines directly. Some of them, however, can be identified because they are at the same level as recognisable landmarks; and the positions of the others can be gauged from them. The **second sacral** spine is at the level of the posterior superior iliac spine; the **fourth lumbar** is at the level of the highest part of the iliac crest; the **seventh thoracic** is at the level of the lower angle of the scapula; and the **third thoracic** is at the level of the point where the crest and medial border of the scapula meet. The **seventh cervical** spine can be identified directly: it is the uppermost of the knobs in the median line at the root of the back of the neck; hence the seventh cervical is called the *vertebra prominens*. Pass your finger upwards over the other cervical spines. The uppermost one felt is the spine of the **second cervical** or **axis** vertebra (the first, or atlas, has no spine); it is about two inches below the **external occipital protuberance** on the lower part of the back of the head. Run your finger from the protuberance in a lateral direction and feel the curved ridge on the back of the skull called the **superior nuchal line.** Between the muscles of the two sides of the back of the neck there is a fibrous partition called the **ligamentum nuchæ**; its posterior edge stretches from the occipital protuberance to the seventh cervical spine. The upper part of the first muscle encountered in the dissection of the back—the *trapezius*—arises from the nuchal line, the protuberance and the ligamentum nuchæ.

Dissection.—Reflexion of the Skin: *Incisions* (Fig. 23):—1. From the tip of the coccyx, upwards, along the median line of the body, to the spine of the seventh cervical vertebra. 2. From that point, transversely to the tip of the acromion. 3. From the lower extremity of the median incision in a curved direction laterally and forwards, along the iliac crest, to within two inches of the anterior end of the crest. 4. An oblique incision from the spine of the first lumbar vertebra, upwards and laterally, to the posterior fold of the axilla, and along that fold to the arm. The two large flaps (17 and 18, Fig. 23) which are now mapped out on the back must be carefully reflected.

Superficial Fascia.—In bodies which have been allowed to lie for some time on the back, the superficial

fascia is usually more or less infiltrated with fluid which has gravitated into its meshes; otherwise it has the ordinary characters of superficial fascia (p. 3).

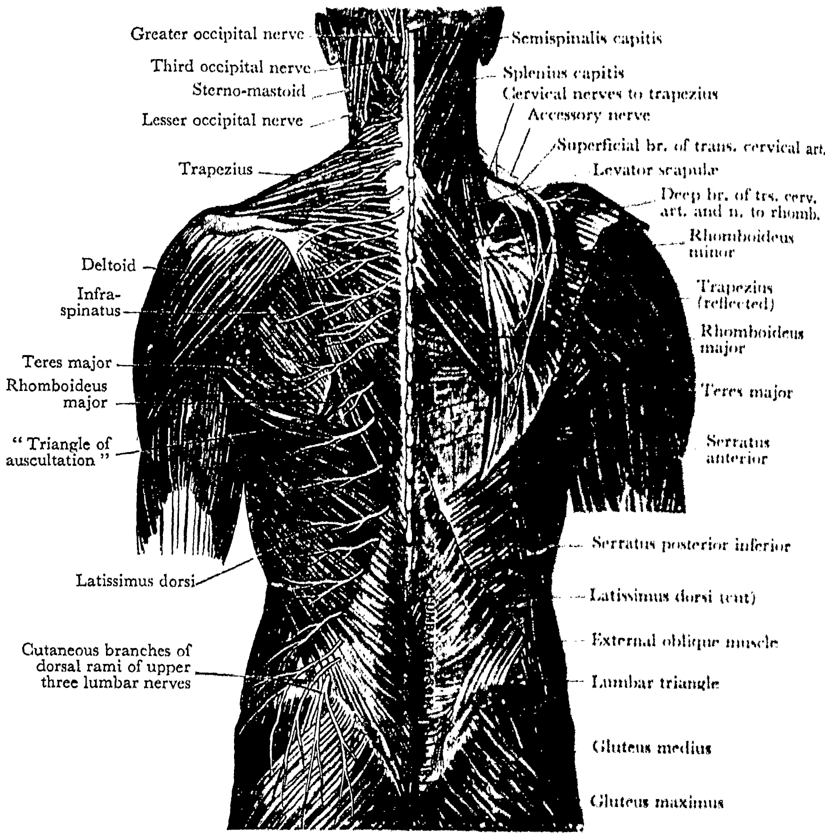


FIG. 24.—Dissection of Superficial Muscles and Nerves of the Back.

Dissection.—When searching for the cutaneous nerves, cut boldly down through the superficial fascia, in the direction in which the nerves run (Fig. 24), until the deep fascia is reached. It is there that the main trunks are to be found, and in a well-injected subject the cutaneous arteries will serve as guides. Trace the nerves laterally through the superficial fascia.

Cutaneous Nerves and Vessels.—The *cutaneous nerves* of the back are derived from the dorsal rami of the spinal nerves. As the dorsal rami pass backwards, they divide into medial and lateral branches (Fig. 1, p. 8). Both branches supply twigs to the muscles amongst which they lie ; but one or the other contains also sensory fibres which come to the surface in the shape of a cutaneous nerve.

In the *thoracic region* the *upper six* or *seven* cutaneous nerves are the terminations of the medial branches and therefore are to be sought for near the median plane, though one or more may pierce the trapezius one or two inches lateral to the line of the others. The branch which comes from the second thoracic nerve is the largest of the series, and may be traced, across the spine of the scapula, as far as the shoulder. The *lower five* or *six* come from the lateral branches of the dorsal rami of the thoracic nerves, and must be looked for at some distance from the median line. The upper nerves of this group pierce the latissimus dorsi muscle on the line of the angles of the ribs. The lower nerves appear at the lateral margin of the erector spinæ muscle by piercing the *thoraco-lumbar fascia*, which is the very thick deep fascia of the small of the back.

Each of these cutaneous branches divides into a small medial branch and a larger lateral branch, which runs laterally and downwards for a varying distance in the superficial fascia.

It is important to note that the area of skin supplied by each of these cutaneous nerves is placed at a lower level than the origin of the dorsal ramus from which it arises.

In the *lumbar region*, three cutaneous nerves reach the surface after piercing the lumbar part of the thoraco-lumbar fascia at the lateral margin of the sacro-spinalis muscle, a short distance above the iliac crest. They are the terminal twigs of the lateral branches of the dorsal rami of the upper three lumbar nerves ; and they differ from the nerves above them in that they turn downwards over the iliac crest to supply the skin of the gluteal region (Fig. 24).

The *cutaneous arteries* which accompany the cutaneous nerves of the back are derived from the posterior branches of the intercostal and lumbar arteries.

DORSAL MUSCLES THAT ATTACH UPPER LIMB TO TRUNK.—There are five muscles in this group, arranged in two strata. The trapezius and the latissimus dorsi form the *superficial stratum*. Both are broad, and they cover the greater part of the back of the trunk from the occiput to the iliac crest. The trapezius lies in the back of the neck and the thorax; the latissimus dorsi lies on the thorax and in the loin. The *deeper stratum* of muscles, composed of the levator scapulæ and the two rhomboid muscles, is under cover of the trapezius.

Dissection.—Clean away the remains of the superficial fascia in the area of the trapezius, taking care of the cutaneous nerves; then clean the *trapezius*. That muscle belongs only in part to the dissectors of the Upper Limb. The portion of it which lies above the spine of the seventh cervical vertebra is the property of the dissectors of the Head and Neck, and must be dissected by them. The dissectors of the two parts should work in conjunction; and when the whole of the trapezius is exposed they should give one another an opportunity of studying it in its entirety.

During this dissection keep the trapezius on the stretch by placing the arm close to the trunk and depressing the scapula over the end of the block which supports the thorax. The muscle should be cleaned from above downwards on the *right side* and from below upwards on the *left side*.

As the deep fascia is removed from the trapezius—and indeed throughout the whole dissection of the back—the cutaneous nerves must be carefully preserved, in order that the dissectors of the Head and Neck may have an opportunity of establishing their continuity with the trunks from which they arise.

Trapezius.—The trapezius is a triangular muscle which lies, in its entire extent, immediately subjacent to the deep

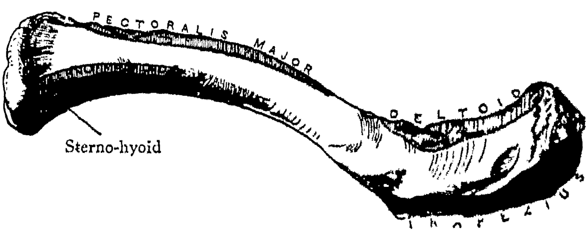


FIG. 25.—Upper Surface of Right Clavicle.

fascia. It has a very long origin which extends, along the median plane, from the occiput to the spine of the last thoracic vertebra. It arises from:—(1) the medial third of the superior nuchal line and from the external occipital protuberance; (2) the ligamentum nuchæ and the spine of the seventh

cervical vertebra ; (3) the tips of the spines of all the thoracic vertebræ, as well as the supraspinous ligaments which bridge across the intervals between them (Fig. 24).

In the lower cervical and upper thoracic regions the tendinous fibres by which the two muscles arise lengthen out to form a flat tendon which is

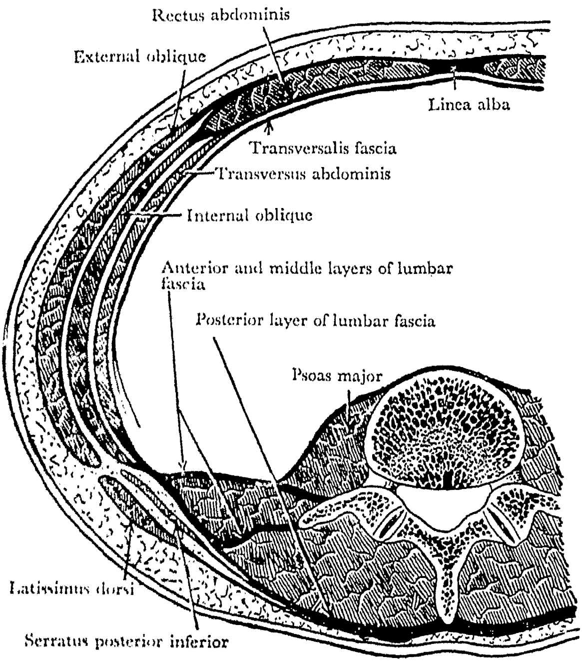


FIG. 26.—Diagram of Thoraco-Lumbar Fascia at level of second lumbar vertebra.

oval or diamond-shaped in outline, thus increasing the effective area of origin for a bulky portion of the muscle; in the living body this is indicated by a depression of corresponding shape when the muscles are contracted.

As the fibres of the trapezius pass laterally they converge upon their insertions into the two bones of the shoulder-girdle. The *occipital* and *upper cervical fibres* incline downwards, and then turn forwards over the shoulder to be inserted into the lateral third of the clavicle (Fig. 25) ; the *lower cervical* and

upper thoracic fibres pass more or less transversely to gain an insertion into the acromion and the crest of the spine of the scapula; and the *lower thoracic fibres* are directed upwards, and, at the medial border of the scapula, end in a flat, triangular tendon which plays over the smooth surface at the end of the scapular spine and is inserted into a rough tubercle on the crest immediately beyond that surface (Fig. 37, p. 92). To facilitate the movement of the tendon upon the bone, a small synovial bursa is interposed between them.

The trapezius is supplied by the *accessory nerve* (p. 63) and also by branches from the *third* and *fourth cervical nerves*, which are probably entirely sensory. From its extensive origin this muscle acts on the scapula in a variety of ways, controlling its position in movements of the upper limb as a whole and of the arm at the shoulder joint. Acting with other muscles, it can elevate or depress the shoulder; it rotates the scapula as the arm is raised above the head; and it can retract the scapula as the shoulders are braced backwards.

Dissection.—The *latissimus dorsi* is now to be dissected. It is a difficult muscle to clean, not only on account of the varying direction of its fibres, but also because its upper part is generally very thin, and its upper border ill-defined.

Put the muscle on the stretch by folding the arm under the neck, and remove the superficial and deep fasciæ in one layer from its surface.

As in the case of the trapezius, work downwards on the right side, upwards on the left.

Define the attachment of the muscle to the thoraco-lumbar fascia, and clean that fascia. Next, define the attachment of the muscle to the iliac crest; and, when the lower part of the lateral border of the latissimus is reached, note the costal slips attached to the lowest three or four ribs, and also the slips of the external oblique muscle of the abdomen which interdigitate with them.

Evert the upper margin of the muscle as it crosses the inferior angle of the scapula, and display the slip which springs from that angle. This scapular slip is liable to be mistaken for a piece of the teres major muscle, upon which it lies.

Latissimus Dorsi.—The latissimus dorsi is a wide, thin muscle which covers the back from the level of the sixth thoracic vertebra down to the iliac crest (Fig. 24). The greater part of it is subcutaneous; but its upper part, near the spines, is under cover of the trapezius. It arises:—(1) from the tips of the lower six thoracic spines and the corresponding supraspinous ligaments; (2) from the thoraco-lumbar fascia (Fig. 26); (3) from the outer lip of the iliac

crest, in front of the fascia (Fig. 24) ; (4) from the lower three or four ribs ; and (5) by a fleshy slip from the back of the inferior angle of the scapula (Fig. 37, p. 92).

Its fibres converge rapidly towards the lower part of the scapula ; and it sweeps over the inferior angle in the form of a thick, fleshy band which winds round the lower margin of the teres major and terminates in a thin, narrow tendon, which is inserted chiefly into the floor of the intertubercular groove of the humerus (Fig. 44, p. 104). The insertion cannot be studied at present, but will be seen later (p. 93).

With the teres major muscle, the latissimus dorsi forms the posterior fold of the axilla. At first it is placed behind the teres major, then it is folded round its lower border, and finally it is inserted in front of it. To the peculiar relationship of the two muscles is due the full, rounded appearance of the posterior axillary fold.

The latissimus dorsi is supplied by a special nerve (C. 6, 7, 8) from the posterior cord of the brachial plexus. It is an adductor, retractor, and medial rotator of the upper limb.

Intermuscular Space.—A triangular space bounded by the trapezius, the latissimus dorsi, and the scapula should now be noticed (Fig. 24). Within the triangle, a small portion of the rhomboideus major muscle can be seen, and also a varying amount of the wall of the thorax—the borders of the sixth and seventh ribs and the space between them. This is the only part of the back of the thorax which is not covered with muscles; it has been called the *triangle of auscultation* because, in the absence of muscles, breath-sounds are supposed to be heard better there than anywhere else on the back.

Dissection.—On the *second day*, reflect the trapezius, working, if possible, with the dissectors of the Head and Neck. Divide the muscle about two inches from the median plane, and throw it towards its insertion. The trapezius is very thin at its origin ; take great care, therefore, not to injure the subjacent rhomboid muscles. Clean and preserve the vessels and nerves on the deep surface of the muscle ; and look for the bursa that lies between its tendon and the medial end of the spine of the scapula.

Nerves and Vessels of Trapezius.—The trapezius gets its nerve-supply from two sources, and the dissectors of the Head and Neck have already displayed the *accessory nerve* (11th Cranial) and the branches from the *third* and *fourth*

cervical nerves as they cross the posterior triangle of the neck. On the deep surface of the trapezius they form a plexus from which twigs proceed into the muscle. The accessory nerve can be traced nearly to the lower end of the trapezius, and it is accompanied by the *superficial branch of the transverse cervical artery* (Fig. 24). Twigs from the *deep branch* of the same artery appear close to the medial border of the scapula.

The inferior belly of the omo-hyoid muscle and the suprascapular artery and nerve must now be displayed, and the insertion of the trapezius examined.

Dissection.—Divide the trapezius by a transverse cut at the level of the angle between the clavicle and the spine of the scapula, and examine the insertion of the muscle. Next, clean away the fat in the area exposed, and display the *inferior belly of the omo-hyoid muscle*, the *suprascapular vessels* and *nerve*, and the fascia over the supraspinatus. The supraspinatus covers the scapula between the spine and the upper border of the bone. The inferior belly of the omo-hyoid is attached to the lateral part of the upper border; follow it upwards into the neck. The suprascapular artery crosses the suprascapular ligament immediately lateral to the omo-hyoid, and the nerve is below the ligament; clean the parts of them seen now.

The next step is to define the muscles that connect the medial margin of the scapula to the vertebral column. From above downwards, they are (1) the *levator scapulæ*, (2) the *rhomboideus minor*, (3) the *rhomboideus major*. Put them on the stretch and clean their surfaces.

Omo-Hyoid, Levator Scapulæ and Rhomboid Muscles.—The **omo-hyoid** muscle stretches from the scapula to the hyoid bone in the neck, and has two slender bellies united by an intervening tendon. The *inferior belly* arises from the suprascapular ligament and the upper border of the scapula, and passes upwards and forwards into the neck to join the tendon.

The **levator scapulæ** is a thick, elongated muscle that arises by slips from the transverse processes of the upper four cervical vertebræ and passes downwards and backwards to be inserted into the medial margin of the scapula from the upper angle to the spine. It is supplied by the *nerve to the rhomboids* and by branches from the *third* and *fourth cervical nerves*.

The two rhomboid muscles extend as parallel bands obliquely downwards and laterally from the spines of the vertebræ to the scapula. The **rhomboideus minor** runs from

the ligamentum nuchæ and the seventh cervical spine to the medial margin of the scapula opposite its spine (Fig. 37, p. 92).

The **rhomboideus major**, about twice the width of the minor, extends from the upper thoracic spines and supraspinous ligaments to the medial margin of the scapula from the spine to the inferior angle (Fig. 37).

The rhomboids are supplied by a special branch (*nerve to the rhomboids*) from the fifth cervical nerve. They pull the scapula upwards and backwards, and help to rotate it.

Dissection.—Complete the cleaning of the *levator scapulæ*, taking care not to injure its nerves. With the dissectors of the Head and Neck, study its attachments and nerve-supply; then divide the muscle across its middle and turn the lower half towards its insertion. Secure the *nerve to the rhomboids* and the *deep branch of the transverse cervical artery*, which lie deep to the muscle, and follow them to the rhomboideus minor.

Next, cut through the rhomboids midway between the scapula and the spines of the vertebræ; remember that they are very thin, and take care not to injure a thin muscle, called the *serratus posterior superior*, which is immediately subjacent to them. Turn the medial part of each muscle towards the vertebral spines, and examine its attachment. Turn the lateral parts towards the scapula, and follow the nerve to the rhomboids and the deep branch of the transverse cervical artery to their terminations.

The **nerve to the rhomboids** (C. 5) is a long, slender nerve that usually arises in common with the upper root of the nerve to the serratus anterior. It passes downwards and laterally and, accompanied by the **deep branch of the transverse cervical artery**, descends under cover of the levator scapulæ and the two rhomboids, near the scapula. It supplies one or two twigs to the levator scapulæ and ends in the rhomboids.

Dissection.—Divide the latissimus dorsi from the inferior angle of the scapula to a point below the origin of the muscle from the last rib. Remember that the muscle is thin, and do not injure the parts subjacent to it. Turn the medial portion towards the vertebral spines—taking special care not to injure a thin muscle, called the *serratus posterior inferior*, which lies in the region of the lower four ribs—and examine the origin of the latissimus (p. 62). Throw the lateral part of the muscle forwards; and, at the inferior angle of the scapula, find its nerve of supply.

Removal of Upper Limb.—(1) Divide the suprascapular artery and nerve and the inferior belly of the omo-hyoid at the upper border of the scapula.

(2) Divide the nerve to the rhomboids and the deep branch of the transverse cervical artery near the upper angle of the scapula.

(3) Pull the scapula away from the ribs, and cut through the

posterior part of the serratus anterior about one inch from its medial margin.

(4) Pull the scapula still farther away from the thorax, and divide the axillary vessels and the brachial plexus at the outer border of the first rib; also the intercosto-brachial nerve.

(5) Detach the anterior skin-flap previously stitched to the anterior wall of the thorax, and take the limb to another table.

(6) In preparation for further dissection, separate the axillary vessels and the cords of the brachial plexus from one another; tie them to a short piece of wood *in their proper relative positions*, and fix it to the coracoid process.

FREE UPPER LIMB

Surface-Anatomy.—Place the fingers on the lateral side of the arm just below the acromion, and move the arm in any direction. The upper end of the humerus is felt moving under cover of the deltoid muscle; the part of it felt is the **greater tubercle** (Figs. 2, 8, 51); the **lesser tubercle** is felt on the front. Follow the shaft downwards until, about half-way down on the lateral side, the **deltoid tuberosity** can be felt—rather indistinctly. Immediately below and behind the tuberosity the **radial nerve** can usually be felt against the bone, though the nerve is covered with muscle. As the elbow is approached, the humerus widens from side to side, and acquires fairly sharp margins—the **lateral** and **medial supracondylar ridges**; the lateral ridge is the more outstanding and the more easily felt. The projecting ends of the ridges are the epicondyles of the humerus. The **lateral epicondyle** is not prominent, but is easily felt in the upper part of a shallow depression on the back of the limb. The **medial epicondyle** is prominent. It can be seen as well as felt. Grip it between finger and thumb, and note that it inclines slightly backwards. The **ulnar nerve** passes behind the medial epicondyle and can be rolled between the finger and the bone. When the arm hangs loosely by the side, the medial epicondyle fits into the curve of the waist and the humerus is then so placed that the lateral epicondyle is well round to the front. It is only when the arm is held with the palm looking forwards that the epicondyles occupy the relative positions indicated by their names; and it should be noted that in this position, owing to the obliquity of the plane of the elbow joint, the forearm is not in line with the upper arm but is directed outwards at the so-called " carrying angle ".

The fleshy, bulging mass on the front of the upper arm is composed chiefly of the **biceps brachii.** Place your fingers on the medial margin of the biceps near the elbow, push the biceps away, press the fingers backwards and move them from side to side: the cord felt is the **median nerve**; and, in the living limb, the pulsations of the **brachial artery** are felt. On each side of the biceps there is a faint, shallow groove. The vein seen through the skin on the surface of the biceps, in front of the lateral groove, is the **cephalic vein.** The vein seen in the medial groove is the **basilic vein.** At the upper part of the medial groove there is a narrow ridge produced by the **coraco-brachialis muscle**; the lower part of the **axillary artery** and the upper part of the **brachial artery** lie close behind and medial to the ridge, and can be seen beating in the living limb. The **tendon of insertion of the biceps** is readily felt in the middle of the front of the elbow when the elbow is bent, and on the medial side of it the edge of the **bicipital aponeurosis** (p. 82) also can be felt.

The **coronoid process** of the ulna is hidden under muscles; but the tubercle on its medial margin can be felt about an inch below the medial epicondyle. The **olecranon** of the ulna is the bony prominence at the back of the elbow; the skin moves freely over the back of it, because a bursa is placed between them. Note the relative positions of the olecranon and the epicondyles during the movements of the elbow (Figs. 27, 28, 95). It is with reference to their normal relative positions that the surgeon can distinguish among the different forms of fracture and dislocation that occur so often at the elbow. When the elbow is straightened out to its full extent, the three prominences lie in the same horizontal plane; when it is bent to a right angle, they are at the angles of a triangle that is nearly equilateral.

The **posterior border of the ulna** is subcutaneous from end to end, and can be felt as a sharp edge that runs downwards from the olecranon. It ends at the styloid process of the ulna (Figs. 2, 3, 75, 79). The **styloid process** makes a blunt ridge on the medial side where the forearm joins the wrist. When the palm faces forwards or upwards, the process is seen and felt at the medial margin of the back of the forearm; when the palm faces backwards or downwards, the process is on the medial surface of the forearm, and, in its

place on the back, there appears a smooth, rounded prominence which is the **head of the ulna.** The distal third of the medial surface of the shaft of the ulna also is subcutaneous and easily felt.

The **head of the radius** lies below the lateral epicondyle, in the lower part of the depression on the back of the limb. Place your finger tip in the depression and feel the transverse

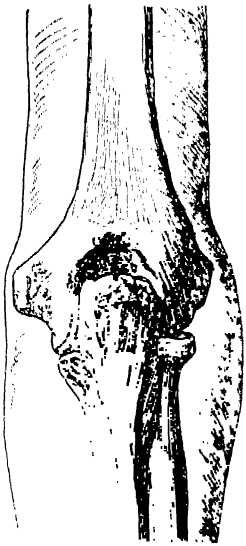


FIG. 27.—Relation of Bones of Elbow to the surface. Dorsal view; elbow fully extended.

FIG. 28.—Relation of Bones of Elbow to the surface. Dorsal view; elbow bent.

groove between the humerus and the head of the radius; rotate the hand backwards and forwards: the head of the radius can be felt rotating, though it is covered by a strong ligament called the **annular ligament.** The **shaft of the radius** is buried among muscles, but can be felt through them. The **distal end of the radius** is a block of bone that can be felt at the distal end of the forearm, on both back and front and also on the lateral side. Feel for its **dorsal tubercle** on the back towards the lateral side. When the living thumb is stretched out from the palm, a hollow appears between the tendons on

the lateral side of the back of the wrist. This hollow is popularly known as the "anatomical snuff-box"; and the **styloid process of the radius** is the bone felt in the upper part of its floor.

Now, examine the palm of your own hand. The **hypothenar eminence** or ball of the little finger is the smooth, soft elevation along the medial side of the hollow of the palm. It overlies the fifth metacarpal bone, and is composed of the short muscles of the little finger. Feel the **pisiform bone** at the upper end of the eminence; the tendon which is felt above it is the *flexor carpi ulnaris*. Grip the pisiform bone between finger and thumb, and note that it can be moved slightly on the **triquetrum,** which is the bone concealed behind the pisiform. The **hook of the hamate bone** also may be felt obscurely a little below and lateral to the pisiform.

The **thenar eminence** or ball of the thumb is the ovoid, fleshy elevation that forms the supero-lateral boundary of the hollow of the palm. It overlies the first metacarpal bone, and is composed of three of the small muscles of the thumb. The tendons of two muscles, called the *flexor carpi radialis* and the *palmaris longus*, are seen descending side by side in the middle of the forearm towards the wrist. The flexor carpi radialis is the more lateral of the two, and it disappears at the upper medial part of the thenar eminence. Place your finger in the angle between the eminence and the tendon; the bone felt there is the **tubercle of the scaphoid.** The **tubercle of the trapezium** is the bone felt indistinctly in the thenar eminence immediately distal to the tubercle. The *skin-crease* that runs across the front of the limb at the level of the uppermost parts of the pisiform and the tubercle of the scaphoid marks the junction of the forearm and the wrist, and marks also the position of the upper border of a very strong ligament called the **flexor retinaculum.**

Several creases traverse the skin of the palm, but are of no service as landmarks. They vary in extent and in relation to each other, but three of them are fairly constant in position. The *upper one* curves round the thenar eminence, and ends at the lateral margin of the hand. The *middle one* begins where the first one ends, runs nearly transversely across the palm, and fades away near the hypothenar eminence. The *lower one* begins near the cleft between the forefinger and middle finger, and runs, with a slight curve, to the medial margin of the hand (Fig. 68, p. 146). Cup the hand and note how these creases deepen as they act like joints in the skin.

The distal boundary of the hollow of the palm is a low, uneven elevation that overlies the **metacarpo-phalangeal joints** of the four fingers. The creases at the root of a finger are about an inch (25 mm.) distal to the metacarpo-phalangeal joint. The upper of the two (or more) creases at the middle of a finger is opposite the first **interphalangeal joint**; but at the second joint the creases are proximal to the joint.

On the lateral surface of the wrist, the **scaphoid** and the **trapezium** lie in the floor of the "snuff-box", between the styloid process of the radius and the first metacarpal, and can be felt if the hand is bent towards the medial side. On the medial surface, the **triquetrum** is easily felt behind the pisiform; the *dorsal branch of the ulnar nerve* can be rolled between the finger and the triquetrum; the triquetrum overlaps the hamate bone so that the hamate bone can scarcely be felt on the medial side.

On the back of the hand, the **carpal bones** are hidden by the extensor tendons as they pass off the radius and ulna. These tendons ridge the skin when the fingers are extended; and they are best identified after they have been dissected (p. 165). The **metacarpal bones** can all be felt through the tendons. The muscles between them are the *dorsal interossei*, of which the first is the largest and the only one visible in the living hand; it can be seen and felt contracting if you bend the forefinger or abduct it from the others. The *bases* or proximal ends of the metacarpal bones form small uneven prominences about an inch below the radius and ulna. Their distal ends or *heads* are the first row of **knuckles.** The **metacarpo-phalangeal joints** are distal to the knuckles. The *heads* of the **phalanges** are the second and third rows of knuckles, and the **interphalangeal joints** are immediately distal to them.

Superficial Structures

The whole of the skin should now be removed from the limb while the subcutaneous tissues are still in good condition, and in order that a general view of the superficial veins and the cutaneous nerves may be obtained. The main superficial veins carry blood to the axillary vein; the cutaneous nerves are either direct branches of the brachial plexus or they spring from the main terminal branches of the plexus.

Dissection.—With the limb on its back, make the following incisions : (1) along the front of the limb from the region already denuded to the tip of the middle finger (Fig. 4) ; (2) transverse at the wrist ; (3) transverse at the roots of the fingers ; (4) obliquely from the middle of the wrist to the tip of the thumb ; (5) along the middle of the index, ring, and little fingers.

Next, remove the flaps, taking great care not to injure the cutaneous vessels and nerves. Reflect the flaps to the margins of the limb and the margins of the digits, and then dissect them from the back of the limb, including the digits.

When the skin is completely removed it must not be thrown away but must be kept to be wrapped round the part when the dissection is not proceeding.

Superficial Fascia.—The superficial fascia presents no peculiarities in the upper arm, the forearm and the back of the hand; the amount of fat in it varies considerably in different subjects; and the dissector will have found that the skin is readily separated from it, except over the epicondyles and the olecranon. In the palm and on the front of the digits, the superficial fascia is dense and is adherent to the skin; for there the skin is bound to the deep fascia by fibrous septa which pass through the superficial fascia dividing it into small loculi occupied by separate lobules of fat. Over the hypothenar eminence some transverse muscle fibres will be brought into view; they connect the skin on the ulnar border of the hand with the deep fascia of the palm, and constitute the *palmaris brevis muscle* (p. 135). It can be brought into action by abducting the little finger against resistance, with obvious puckering of the skin. A loose, slender band of fibres, called the *superficial transverse metacarpal ligament* (Fig. 63, p. 137), lies in the superficial fascia across the roots of the fingers and in the webs between them. When the hand is put into the position in which it grasps a spherical object, this ligament is put on the stretch and the palmaris brevis contracts, and they thus assist in deepening the " cup " of the palm.

Superficial Veins.—The subcutaneous veins should be dissected first, because they are, except here and there, the most superficial structures (Figs. 32, 33) ; but be careful to preserve any nerves met with as the veins are being cleaned.

Dissection.—Follow the *cephalic vein* downwards from the groove between the pectoralis major and the deltoid, and preserve its tributaries. At the bend of the elbow, secure and clean a large communicating branch, called the *median cubital vein,* which runs obliquely upwards to join the *basilic vein.* Secure also a vein

which pierces the deep fascia and connects the median cubital vein with the deep veins of the forearm.

Follow the cephalic vein down the forearm and round its radial margin to its origin from the *dorsal venous arch*. Trace the dorsal venous arch across the back of the hand to the ulnar side, where the *basilic vein* arises from it. Follow the basilic vein upwards through the forearm, and then upwards in front of the medial epicondyle, and onwards to the middle of the upper arm where it pierces the deep fascia. As you clean it, look for the *superficial cubital lymph-nodes*, which lie in the superficial fascia a little above the medial epicondyle. Note any variations of the superficial veins that may be present (see p. 74).

Return to the dorsal venous arch and clean its tributaries.

The superficial veins must now be studied.

Dorsal Venous Arch.—This arch usually lies across the lower part of the back of the hand; but it is inconstant in position and shape, as the dissectors may see if they compare their own hands. It gives origin to the basilic and cephalic veins; and it receives numerous tributaries including the three *dorsal metacarpal veins*, which lie in the spaces between the metacarpal bones of the fingers.

Two *dorsal digital veins* lie along the margins of the back of each digit, and are connected by *venous arches*. The dorsal digital veins of the thumb join the cephalic vein; the radial one of the index joins the dorsal venous arch; the ulnar one of the little finger joins the basilic vein; the others end in the dorsal metacarpal veins. Communicating veins that pass through the intermetacarpal spaces connect the veins of the back of the hand with the veins of the palm.

Cephalic Vein.—The cephalic vein begins at the radial end of the dorsal venous arch. It receives the two dorsal digital veins from the thumb, and then turns round the radial border of the distal part of the forearm and ascends to the front of the elbow; there, the greater part of its blood is transmitted to the basilic vein by the median cubital vein. It then ascends along the lateral surface of the biceps to the lower border of the pectoralis major; there, it pierces the deep fascia (Fig. 32), and proceeds upwards in the groove between the pectoralis major and the deltoid to the infraclavicular fossa. There it has been seen already piercing the clavi-pectoral fascia (p. 35) to join the axillary vein (p. 36).

Basilic Vein.—The basilic vein begins at the medial end of the dorsal venous arch. It receives the dorsal digital vein from the medial side of the little finger, and then ascends along the medial surface of the forearm—often as two channels which unite before they reach the elbow. Near the elbow, it inclines forwards to ascend in front of the medial epicondyle. An

inch or more above the medial epicondyle, it is joined by the median cubital vein. It then runs along the medial margin of the biceps to the middle of the upper arm, where it pierces the deep fascia opposite the insertion of the coraco-brachialis. After it has pierced the deep fascia, it runs along the medial side of the brachial artery to the lower border of the teres

FIG. 29.—Superficial Veins at bend of Elbow in a specimen in which the Median Vein was large.

major, where it becomes the axillary vein. Only the termination of this, upper, part of the vein can be seen at present; the remainder will be displayed in a later dissection.

Median Cubital Vein.—This is a large communicating vein which springs from the cephalic vein about an inch below the bend of the elbow, and runs obliquely up to join the basilic vein about an inch above the medial epicondyle. As it crosses from the cephalic to the basilic vein, it receives tributaries from the front of the forearm, is connected with the deep veins, and is separated from the distal part of the brachial artery by a portion of deep fascia thickened by an expansion from the biceps tendon called the *bicipital aponeurosis* (Fig. 32).

Variations of Superficial Veins.—The arrangement of the veins of the forearm and their course in front of the elbow are subject to variation. A *median vein of the forearm* may be larger than the cephalic vein in that region, in which case it divides in front of the elbow into a *median basilic* (which replaces the median cubital) and a *median cephalic* which receives the cephalic and continues its course upwards under that name (Fig. 29). The median cubital (or median basilic) is the usual vein for venesection or intravenous injections as in blood-transfusion.

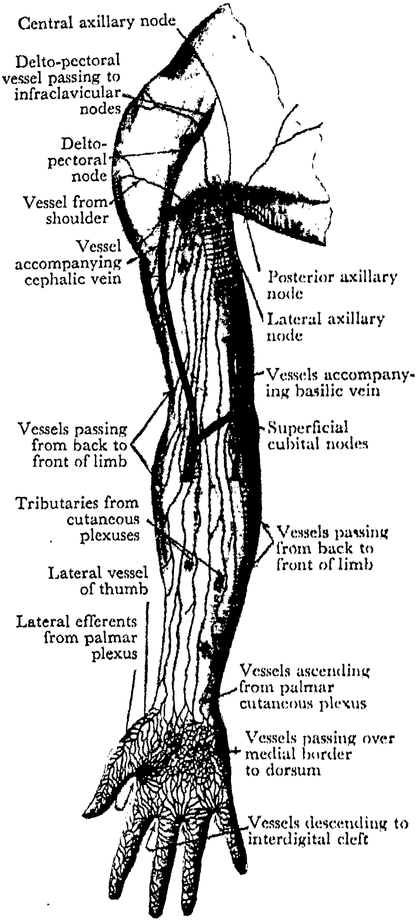


FIG. 30.—Superficial Lymph-Vessels and Lymph-Nodes of Front of Upper Limb.

Lymph-Vessels and Lymph-Nodes of Upper Limb.—In an ordinary dissecting-room part, it is impossible to display the lymph-vessels of the limb in a satisfactory manner. The dissectors will have seen some of the axillary nodes, and may have found a superficial cubital and possibly a delto-pectoral node. But they will not have been able to trace the lymph-vessels except for short distances near those nodes.

At this stage it is, however, worth their while to review the general arrangement of lymph-vessels and lymph-nodes in the limb, since it has a certain general relation to the pattern of the main superficial veins.

As in other parts of the body, both the vessels and the nodes are arranged in two main groups—superficial and deep.

The **superficial lymph-nodes are** (1) the infraclavicular (p. 41) and delto-pectoral nodes (p. 31), and (2) the *superficial cubital nodes*, which are two small nodes that lie a little above the medial epicondyle near the medial side of the basilic vein, and are liable to become inflamed and painful when wounds of the ulnar border of the hand fester.

The **deep lymph-nodes** lie along the course of the main blood-

vessels. The chief groups are in the axilla, but in addition to them there are a few along the medial side of the brachial artery and at its bifurcation (deep cubital). Occasionally, small nodes are found in relation to the radial, ulnar, and interosseous arteries.

The **deep lymph-vessels** receive the lymph from all the structures that are deep to the deep fascia, but they are much less numerous than the superficial vessels. They accompany the main blood-vessels and end in the nodes alongside the axillary vessels—some of them being interrupted in the nodes related to the brachial artery.

The **superficial lymph-vessels** collect the lymph from the skin and the subcutaneous tissues, and they also ultimately reach the nodes in the axilla. As they traverse the limb they anastomose with one another to some extent, but each retains a definite individuality throughout its course. The paths which they take are determined by the main trend of the stream: (*a*) as the vessels begin to run up the forearm from the hand, most of them run towards the back of the wrist rather than the front; (*b*) in their course towards the axilla, all these vessels and most of those which arise in the forearm and upper arm come to the medial side of the front of the upper arm and run along the line of the basilic vein (Figs. 30, 31).

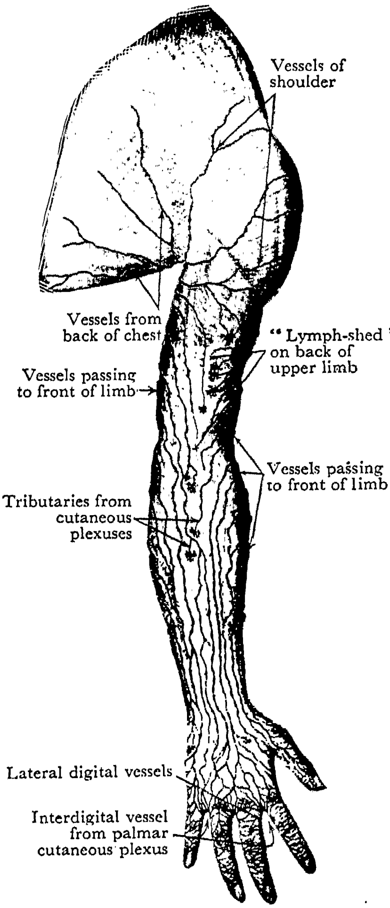


FIG. 31.—Superficial Lymph-Vessels of Back of Upper Limb.

As the lymph-vessels of the front of the digits ascend, they curve round the sides to join those on the back. In the palm of the hand there is a dense cutaneous network of lymph-capillaries from which the lymph-vessels arise. Those of the vessels that run upwards over the front of the wrist are only the few that arise from the proximal margin of the plexus. Those from the distal margin descend to the interdigital clefts

and join the vessels of the fingers. Others arise in the lateral and medial margins of the plexus and curve over the borders of the hand on to the back, where they are joined by the vessels from the fingers. All of the vessels of the fingers and most of the vessels of the palm therefore ascend across the back of the wrist. In their further ascent, they gradually curve round the borders of the forearm, and sweep up the medial side of the front of the upper arm, to end in the nodes alongside the axillary vessels. One or two vessels from the ulnar border of the hand end in the superficial cubital nodes ; the efferent vessels of those nodes, together with a few other vessels, pierce the deep fascia with the basilic vein and accompany it to the axilla ; the remaining vessels do not pierce the deep fascia till they reach the axilla. One or two lymph-vessels from the lateral side of the forearm and upper arm leave the main stream and accompany the cephalic vein—either to end in the delto-pectoral nodes or to proceed direct to the infraclavicular nodes. The lymph-vessels of the deltoid region run an independent course to the nodes in the axilla —some of them crossing the delto-pectoral groove before they pierce the deep fascia.

The student should compare the arrangement of the superficial lymph-vessels of the Upper and Lower Limbs (see pp. 307-309 and cf. Figs. 30, 31, and Figs. 153, 154). They begin in a similar manner in the hand and in the foot; and in each limb two streams are formed—a chief and a subsidiary—each associated with a vein.

Cutaneous Nerves of Upper Arm and Forearm.—When the superficial veins and their connexions have been studied, the cutaneous nerves of the upper arm and the forearm must be identified and cleaned (Figs. 32, 33).

Dissection.—Find the cut end of the *intercosto-brachial nerve* and trace this nerve downwards through the medial side of the upper arm.

Next, identify the two cutaneous branches of the medial cord of the brachial plexus. Pull gently on the *medial cutaneous nerve of the arm*. Note that it does not pierce the deep fascia till it is near the middle of the upper arm. From that point, trace it downwards as far as the elbow.

The *medial cutaneous nerve of the forearm* is the thicker of the two. It does not pierce the deep fascia till it reaches the middle of the upper arm. Look for small branches that pierce the deep fascia above that level. Secure the nerve where it pierces the deep fascia, and follow it downwards. Near the elbow it divides into two branches. Trace them downwards through the fat on the medial side of the forearm to their terminations at the wrist.

Look for the remains of the *posterior supraclavicular nerves* (Fig. 5), and trace them through the fat over the upper half of the deltoid.

Identify the *posterior cutaneous nerve of the arm*, which springs from the radial nerve in the axilla. Trace it downwards through the fat of the back of the upper arm.

Next, examine the back of the scapular region and find the posterior border of the deltoid muscle. Make an incision through the fascia along the lower half of that border, and secure the *upper lateral cutaneous nerve of the arm* (a branch of the circum-

flex); trace its branches through the fascia over the lower half of the deltoid (Figs. 32, 33).

Now, look for the *lower lateral cutaneous nerve of the arm.* It is often difficult to find it. It pierces the deep fascia about an inch below the insertion of the deltoid. Trace it downwards through the lateral part of the front of the upper arm. The *posterior cutaneous nerve of the forearm* pierces the deep fascia an inch lower. Follow it downwards behind the lateral epicondyle, and along the back of the forearm. The origins of these two branches of the radial nerve will be displayed when the back of the upper arm is dissected (Fig. 47).

Turn to the front of the limb again, and find the *lateral cutaneous nerve of the forearm.* It appears at the lateral border of the biceps, under cover of the cephalic vein about an inch above the bend of the elbow, and soon divides into two branches; trace them along the lateral side of the forearm to the hand.

Before proceeding to examine the cutaneous nerves of the hand, the dissectors should study the position and distribution of the cutaneous nerves of the upper arm and of the forearm, all of which they have now displayed (Figs. 32, 33).

The **posterior supraclavicular nerves** (C. 4) cross the lateral third of the clavicle, and diverge from one another to supply the skin over the upper half of the deltoid.

The **upper lateral cutaneous nerve of the arm** (C. 5, 6) springs from the circumflex nerve under cover of the posterior border of the deltoid muscle, curves round that border at the junction of its lower and middle thirds, runs forwards dividing into diverging branches, and supplies the skin over the lower half of the deltoid.

The **medial cutaneous nerve of the arm** (T. 1, 2) springs from the medial cord of the brachial plexus, and supplies the skin on the medial side of the lower half of the upper arm (behind the basilic vein) and the adjoining part of the back of the arm.

The **intercosto-brachial nerve** (T. 2) emerges from the second intercostal space, crosses the axilla, pierces the deep fascia of the upper arm about an inch below the posterior fold of the axilla, and descends almost to the olecranon. Its branches supply the skin of the floor of the axilla, the skin on the proximal part of the upper arm behind the brachial artery, and a variable area of skin on the back of the upper arm. It communicates with the preceding nerve.

The **posterior cutaneous nerve of the arm** (C. 5, T. 2) arises in the axilla from the radial nerve. It pierces the deep fascia a little below the posterior fold of the axilla, and runs

towards the olecranon. It supplies a wide area of skin on the back of the upper arm from the level of the deltoid tuberosity to the elbow.

The **lower lateral cutaneous nerve of the arm** (C. 5, 6) takes origin from the radial nerve before it leaves the radial groove of the humerus, pierces the deep fascia an inch below the deltoid tuberosity, and supplies the skin of the front of the upper arm, lateral to the cephalic vein, from the deltoid tuberosity to the elbow.

The **posterior cutaneous nerve of the forearm** (C. 6, 7, 8) arises with the preceding nerve and pierces the deep fascia an inch or less lower down. It passes downwards behind the lateral epicondyle and descends on the back of the forearm to the wrist. It gives a few branches to the skin of the lateral part of the upper arm, and supplies the skin of the middle of the back of the forearm from the elbow to the wrist.

The **lateral cutaneous nerve of the forearm** (C. 5, 6) is the continuation of the musculo-cutaneous nerve. It pierces the deep fascia at the lateral side of the biceps, about an inch above the bend of the elbow, behind the cephalic vein. It soon divides into two branches—*anterior* and *posterior*—which run to the lateral side of the wrist. They supply the skin of the lateral side of the forearm both on the front and on the back; and the anterior branch supplies the skin of the upper part of the ball of the thumb.

The **medial cutaneous nerve of the forearm** (C. 8, T. 1) arises from the medial cord of the brachial plexus. It pierces the deep fascia about the middle of the upper arm, in close relation to the basilic vein (Fig. 32). At a varying point above the elbow it divides into *anterior* and *posterior* branches which descend along the medial side of the forearm to the wrist. The anterior branch as it enters the forearm is usually behind but may pass in front of the medial cubital vein. Small branches supply the skin of the front of the upper arm between the basilic and cephalic veins. The terminal branches supply the skin of the medial half of the forearm.

Cutaneous Nerves of Hand.—After the dissectors have reviewed the cutaneous nerves of the upper arm and forearm, they will proceed to dissect the cutaneous nerves of the hand (Figs. 32, 33, 63).

Dissection.—Find the palmar cutaneous branches of the median and ulnar nerves in relation to tendons already identified in front of the wrist.

The *palmar cutaneous branch of the median nerve* pierces the deep fascia between the tendons of the flexor carpi radialis and palmaris longus (p. 69), or near them ; trace it to the middle of the palm. The *palmar cutaneous branch of the ulnar nerve* pierces the deep fascia near the lateral margin of the tendon of the flexor carpi ulnaris (p. 69) ; trace it also into the palm.

Define the *superficial transverse metacarpal ligament* (p. 71), and then remove the superficial fascia from the area between the ball of the thumb and the roots of the fingers in order to expose a thick sheet of deep fascia called the *palmar aponeurosis.*

Opposite the distal ends of the metacarpal bones, the palmar aponeurosis divides into slips—one for each finger. Look for the three *palmar digital nerves* between those slips. Divide the superficial transverse ligament in order to expose them more fully, and trace their branches along the sides of the fingers, cleaning also the digital arteries which accompany them. Find another digital nerve on the hypothenar eminence and trace it to the medial side of the little finger. Pass to the other border of the palm and find the digital branch for the radial side of the forefinger at the lateral margin of the slip of the aponeurosis for that finger, and trace the nerve onwards. Close to the thenar eminence, look for the two digital nerves of the thumb and follow them along the sides of the thumb. Careful dissection will show that some of the finer branches of the digital nerves end in minute, ovoid bodies called *lamellated corpuscles.*

Turn now to the back of the hand. Scrape away the fat on the medial side of the wrist below the styloid process of the ulna, and find the *dorsal branch of the ulnar nerve* ; trace its branches to the little finger and the ring finger. Next, pass to the lateral surface of the lower end of the radius ; find the *terminal part of the radial nerve*, and trace its branches to the back of the thumb, the forefinger, the middle finger, and the ring finger.

The upper part of the skin of the ball of the thumb is supplied by the terminal twigs of the anterior branch of the lateral cutaneous nerve of the forearm ; the palmar digital nerves of the thumb supply the lower part. The rest of the skin of the palm is supplied by the palmar cutaneous branches of the median and ulnar nerves. At present, the dissectors can see only the lower parts of these two nerves (Fig. 32) ; their upper parts will be seen when the deeper parts of the front of the forearm are dissected (p. 143).

The palmar cutaneous branch of the median nerve (C, 6, 7, 8) arises about an inch above the wrist and descends, branching, to supply the skin of the hollow of the palm.

The palmar cutaneous branch of the ulnar nerve (C. 7, 8) is a very slender nerve that arises at a variable point below the middle of the forearm, pierces the deep fascia near

the wrist, and supplies the skin of the medial third of the palm.

The **dorsal branch of the ulnar nerve** (C. 7, 8) is larger. It also arises at a varying point below the middle of the forearm, and its origin will be examined later. It descends with the ulnar nerve, under cover of the flexor carpi ulnaris, almost to the pisiform bone. Then, inclining backwards, it emerges from under cover of the tendon, and descends obliquely across the medial surface of the carpus. It divides into two *dorsal digital nerves* which supply the skin of the medial third of the back of the hand and the skin of the back of the little finger and medial half of the ring finger as far as the end of the second phalanx. The nerve can often be felt through the skin as it crosses the medial surface of the carpus.

The **terminal part of the radial nerve** (C. 6, 7, 8) pierces the deep fascia about two inches above the styloid process of the radius. It descends towards the " anatomical snuff-box ", crossing the tendons that overlie the lateral surface of the distal end of the radius, and divides into five *dorsal digital nerves*—two for the thumb and three for the fingers. They supply the skin of the lateral two-thirds of the back of the hand, and the skin of the back of the following digits as far as the end of the first phalanx—thumb, forefinger, middle finger, and lateral half of the ring-finger. The radial nerve and some of its branches can often be felt through the skin as they cross the distal end of the radius and the extensor tendons of the thumb.

The dorsal branch of the ulnar nerve often contains fibres of the seventh cervical nerve. When that is the case it gives off a branch that either replaces or assists the radial nerve in the supply of the contiguous halves of the ring and middle fingers.

The terminal parts of the backs of the digits are supplied by twigs that curve backwards from the palmar digital nerves. But the extent to which the dorsal and the palmar digital nerves supply the backs of the digits is variable, and the dorsal nerves of the thumb and little finger may reach the root of the nail.

Palmar Digital Nerves.—There are seven palmar digital nerves. Two of them spring from the ulnar nerve and are distributed to the little finger and the medial half of the ring-finger. The others arise from the median nerve and

are distributed to the other three and a half digits (Figs. 63, 64). They are visible only on the digits at present ; their origin and course in the palm will be seen when the hand is dissected (p. 135). They are accompanied by the palmar digital vessels, which are in front of them in the palm and behind them on the sides of the digits. They supply the joints of the digits and the soft parts on the sides and the front of the digits and a variable extent of skin on the distal part of the back. Each terminates at the end of the digit by dividing into two branches, one of which ramifies in the pulp of the digit, and the other in the bed of the nail.

The **palmar digital branches of the ulnar nerve** (C. 7, 8) arise from the superficial terminal branch of that nerve. They begin on the hypothenar eminence about an inch below the pisiform bone under cover of a small muscle called the palmaris brevis. The medial branch runs to the medial side of the little finger. The lateral branch divides near the cleft between the little finger and the ring-finger into two branches which run along the contiguous sides of those fingers.

The **palmar digital branches of the median nerve** (C. 6, 7, 8) spring from the two terminal divisions of the median nerve in the upper part of the hollow of the palm. The medial two run towards the webs between the fore, middle, and ring fingers and divide to run along the contiguous sides of those fingers. The third runs to the radial side of the forefinger. The lateral two branches curve laterally round the lower margin of the thenar eminence, and run along the two sides of the thumb. The most medial of the digital branches of the median nerve sends a communicating twig to the adjoining branch of the ulnar nerve.

Lamellated Corpuscles.—These are minute ovoid bodies that lie amidst the fat on the digits, and are attached to the ends of the terminal branches of digital nerves. They are *end-organs* associated with the sense of touch.

Dermatomes.—When the dissection of the cutaneous nerves of the limb is complete, the dissectors should review their " root-values ", *i.e.*, the spinal nerves from which they are derived; and, by reference to text-book diagrams, they should study the arrangement of the segmental areas or " dermatomes " of the skin.

Dissection.—Remove the remains of the superficial fascia from all parts of the limb, and examine the deep fascia. On the back of the hand it is very thin, so be careful not to remove it with the superficial fascia.

Deep Fascia

The deep fascia of the upper limb consists chiefly of transverse fibres which are bound together by oblique and longitudinal fibres. The oblique and longitudinal fibres become specially developed in certain situations which will be noted later.

Turn first to the *scapular region*, and identify four muscles there—the deltoid, teres major and minor, and the infraspinatus. The first two have been examined already. The infraspinatus almost fills the infraspinous fossa. The teres minor is a narrow muscle that lies on the dorsum of the scapula along its lateral margin, so closely applied to the infraspinatus that it may appear to be part of it. The deep fascia on the anterior and lateral surfaces of the deltoid is fairly strong. On the posterior surface of the deltoid and on the other three muscles, it is very strong and dense, especially over the infraspinatus. From its deep surface, it sends in a strong septum between the infraspinatus and the teres minor to be attached to the dorsum of the scapula, and another between the two teres muscles to be attached to the lateral margin of the scapula. As it extends over the two teres muscles towards the deltoid, it splits into two layers which enclose the deltoid.

In the *upper arm*, the deep fascia consists largely of transverse fibres. On the front, where it covers the biceps, it is thin, but it is much stronger at the back, over the triceps. From its deep surface, it sends in septa between muscles, including two strong sheets, called the **lateral** and **medial intermuscular septa**, which bind it to the lateral and medial supracondylar ridges of the humerus. Those septa will be examined when the upper arm is dissected.

At the *elbow*, it is thickened and strengthened by tendinous fibres which pass to it from the biceps and triceps muscles; and it is closely attached to the lateral and medial epicondyles of the humerus and to the olecranon. A special thickening, the **bicipital aponeurosis**, is found at the front of the elbow (Fig. 32). It is part of the insertion of the biceps muscle (p. 105), from which it springs on its medial border. It blends with the deep fascia on the medial side of the upper part of the forearm and separates the median cubital vein, which lies superficial to it, from the brachial artery, which is deep to it.

PLATE V

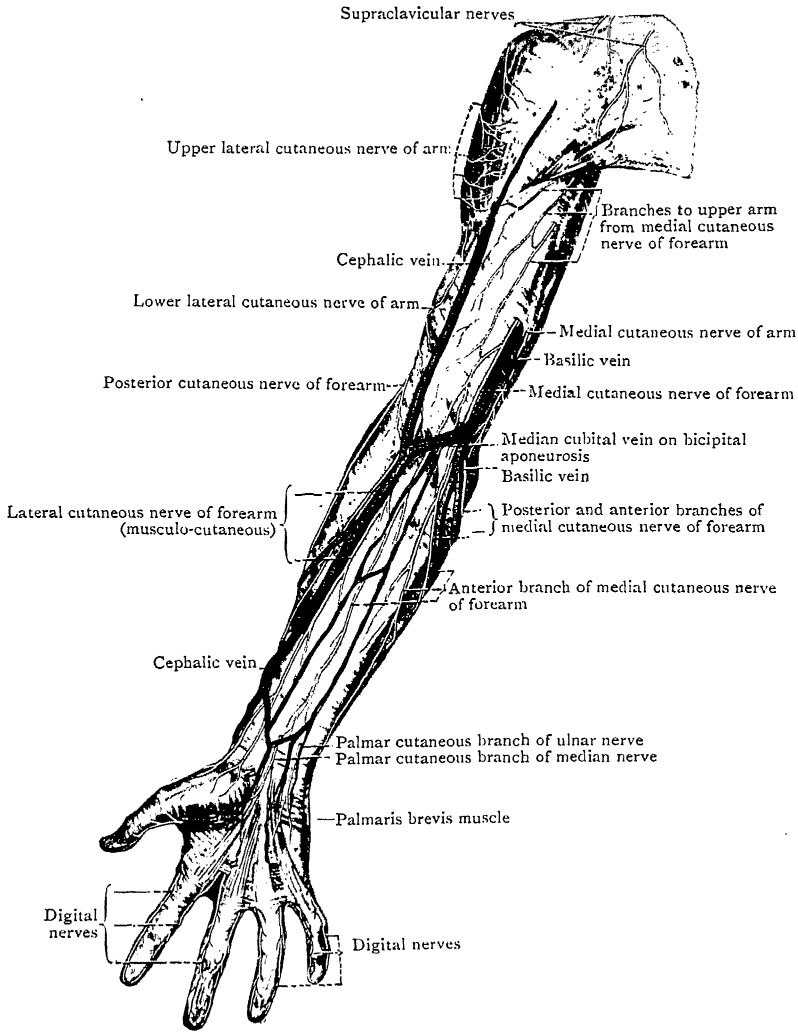


FIG. 32.—Superficial Veins and Nerves of Front of Upper Limb.

[*Facing p.* 8:

PLATE VI

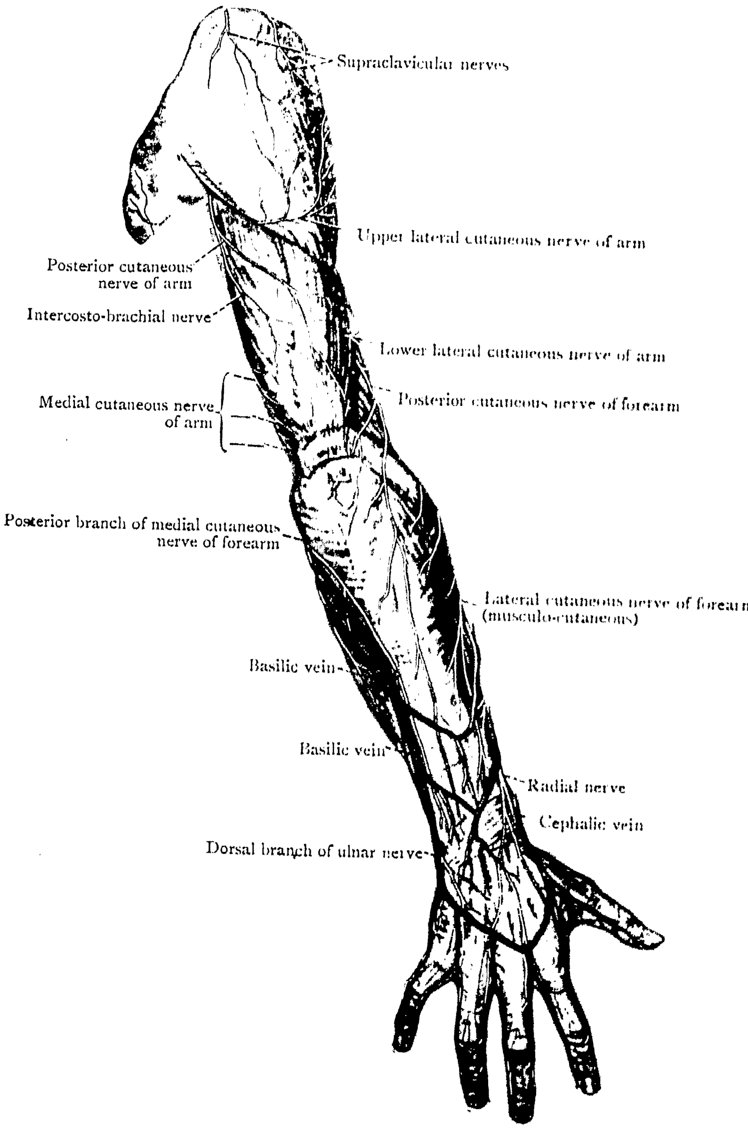


FIG. 33.—Superficial Veins and Nerves of Back of Upper Limb.

[*Facing p.* 83

In the *forearm*, the deep fascia is dense except in the lower part anteriorly. It is especially strong near the elbow, where it gives partial origin to the muscles which arise from the epicondyles. It sends in strong septa between the fleshy bellies of those muscles; the positions of the septa are indicated on the surface by white lines. At the back, it is firmly bound to the posterior border of the ulna in its whole length, and thus separates the muscles on the medial surface of the ulna from those on the back.

At the *wrist*, the transverse fibres of the deep fascia become very obvious. On the back, they form a well-marked band called the *extensor retinaculum*; on the front, they are incorporated in a shorter but much thicker band called the *flexor retinaculum* (Figs. 53 and 69).

Both bands are attached to the adjacent bones; they act as straps which bind down tendons, and prevent them from springing away from the bones when the hand is bent forwards or backwards.

The **flexor retinaculum** (Figs. 64, 66) is a thick, strong band, about an inch square, continuous above and below with the deep fascia of the forearm and palm. It lies immediately distal to the best-marked crease at the lower end of the front of the forearm, and it bridges across the carpal groove, converting it into a tunnel for the long flexor tendons to pass through. It is attached to the bones that form the sides of the carpal tunnel—the pisiform and the hook of the hamate on the medial side, the tubercle of the scaphoid and the front of the trapezium on the lateral side. The retinaculum is hidden to a large extent at present by the structures that cross it and by the muscles of the thenar and hypothenar eminences that arise from it. Its connexions and relations will be examined fully when the hand is dissected (p. 142).

Turn now to the *back of the limb* and identify the **extensor retinaculum** (Fig. 76)—a thickened part of the deep fascia, nearly an inch wide, that lies obliquely across the back of the limb where the forearm joins the wrist. Its deep surface sends off septa that divide the space under its cover into six compartments. These compartments transmit the extensor tendons and are lined with their synovial sheaths. The compartments and the connexions of the retinaculum will be examined later (p. 153).

Before you leave the back of the limb, note again how thin

the deep fascia is on the back of the hand ; as it passes on to the backs of the *digits*, it may become indistinguishable by adhering to the extensor tendons.

Turn again to the front, and examine the deep fascia of the *palm*. The portions that cover the thenar and hypothenar eminences are thin; the intermediate, triangular portion is dense and strong, and is called the palmar aponeurosis.

The **palmar aponeurosis** (see p. 136) conceals and protects the main vessels and nerves and the tendons, as they pass towards the fingers. Its apex blends with the distal border of the flexor retinaculum, and, more superficially, receives the tendon of the palmaris longus. From its distal border processes pass to the fingers where they blend with the fibrous sheaths of the flexor tendons.

The deep fascia on the palmar surfaces of the *digits* is thick and strong. It forms dense, curved plates or shields, called the **fibrous flexor sheaths** These plates are attached by their edges to the margins of the phalanges, with which they thus form a tunnel in which the flexor tendons of the digit lie protected; and the tunnel is lined with the synovial sheath of the tendons. The arrangement and connexions of the palmar aponeurosis and the flexor sheaths will be studied in more detail when the hand is dissected (pp. 136 and 143).

SHOULDER (SCAPULAR REGION)

Muscles between Trunk and Shoulder-Girdle.—Before proceeding with this dissection review the attachments of these muscles—pectoralis minor to the coracoid process; trapezius to the clavicle, acromion and spine of scapula; inferior belly of omo-hyoid from the upper border of the scapula; levator scapulæ and the rhomboids to the medial border; and serratus anterior to that border and the upper and lower angles on their costal aspect.

Dissection.—Cut away the greater part of the muscles between trunk and shoulder-girdle, leaving about one inch of each for future identification. Place a small block in the axilla, fix the scapula to it with hooks, and bend the arm over the block to make the fibres of the *deltoid muscle* tense. Detach the *upper lateral cutaneous nerve of the arm* from the deep fascia, and turn it backwards to the posterior border of the deltoid ; then clean the

deltoid. On the *left side*, begin at its posterior border and reflect the deep fascia forwards. On the *right side*, begin in front and reflect the fascia backwards.

Deltoid Muscle.—The deltoid is a typical multipennate muscle, being composed of short, coarse fasciculi, separated by tendinous intersections ; and, as its name implies, it is triangular in outline. It arises, by its upper end or base :—(1) from the lateral third of the clavicle ; (2) from the acromion ; and (3) from the crest of the spine of the scapula. Its origin corresponds closely with the insertion of the trapezius. Its bundles or fasciculi converge rapidly as they pass to a pointed, tendinous insertion into the *deltoid tuberosity* of the humerus (Figs. 44, 46). The muscle is supplied by the branches of the circumflex nerve which enter its deep surface.

The form of the deltoid and the manner in which it clasps the shoulder determine its actions. Its anterior and posterior portions are opposed to each other: the anterior fibres act with the pectoralis major (clavicular head) in flexing the arm at the shoulder joint (p. 32), and in medial rotation; the posterior fibres, acting with other muscles, reverse these movements. The acromial part of the deltoid is the chief agent in abduction at the shoulder joint, a stage in the action of raising the arm above the head (p. 119).

***Dissection.*—Place the limb on its back. Release the axillary vessels and the nerves from the coracoid process, and clean the angle between the humerus and the scapula. Follow the *circumflex nerve* and the *posterior circumflex humeral artery* backwards to a cleft between the subscapularis and the teres major. Separate those muscles and note that a thick strap of muscle, the *long head of the triceps*, crosses the triangular interval between them and divides it into a lateral part called the *quadrangular space* and a medial part called the *triangular space* (Fig. 35). The circumflex nerve and the posterior humeral circumflex artery pass backwards through the quadrangular space. Now, reverse the limb, push the posterior border of the deltoid forwards and find them as they emerge from the quadrangular space to curve forwards round the surgical neck of the humerus.**

At this stage, cut the deltoid from its origin and turn it towards its insertion, taking care not to injure the circumflex arteries and nerve; and then clean the vessels and nerve.

Clean the circumflex nerve with caution. Secure a small *articular twig* that springs from it in the quadrangular space and passes up to the capsule of the shoulder joint. Note that the nerve splits into two branches after this twig is given off. Secure

the *nerve to teres minor*, which springs from the posterior branch before it turns round the posterior border of the deltoid. Trace the branches of the anterior division into the deltoid.

Clean the teres major and minor muscles from end to end, preserving their nerves of supply. Clean also the long head of the triceps—upwards to its origin and downwards to its junction with the other heads of the triceps—and preserve its nerve-supply, which is found arising from the radial nerve in the axilla and entering the front of the head.

Then, examine the *subacromial bursa*. It lies below the acromion. Thrust a blowpipe into it. If its wall is uninjured, it can be distended with air. Open it; gauge its extent with the finger, and note whether it is single or subdivided.

Turn the limb on to its back once more. Pull the *coraco-brachialis* and *short head of the biceps* medially, and expose the tendon of the *long head of the biceps* in the intertubercular groove. Then, pull them laterally to expose a thick tendon—the tendon of the *subscapularis*. Clean that tendon to its insertion. Clean also the *anterior humeral circumflex artery*, which runs laterally deep to the short head and the coraco-brachialis.

Now, re-examine the structures that lie under cover of the deltoid, and note their relative positions.

PARTS UNDER COVER OF THE DELTOID.—The deltoid covers the upper part of the humerus, and envelops the region of the shoulder joint behind, laterally and in front; and its anterior border covers the coracoid process and the muscles and ligaments attached to it. It is separated from the shoulder joint by the muscles attached to the upper end of the humerus and by the subacromial bursa; and it covers also the long head of the biceps in the intertubercular groove and the greater part of the circumflex nerve and vessels.

The full, rounded appearance of the shoulder is due to the deltoid passing over the upper end of the humerus and those muscles. When the head of the humerus is dislocated, the muscle passes vertically from its origin to its insertion, and the dislocation is recognised by the squareness or flatness of the shoulder.

Subacromial Bursa.—This is a large bursal sac that separates the acromion and the upper part of the deltoid from the muscles that lie on the upper surface of the capsule of the shoulder joint. It varies in size in different bodies, but, when distended, may be as large as a hen's egg; it may be a single sac or divided by fibrous partitions, and it may communicate with a smaller *subdeltoid bursa* between the muscle and the greater tubercle of the humerus. These bursae facilitate the play of the upper end of the humerus and the attached

muscles on the under surface of the coraco-acromial arch (p. 90) and deltoid.

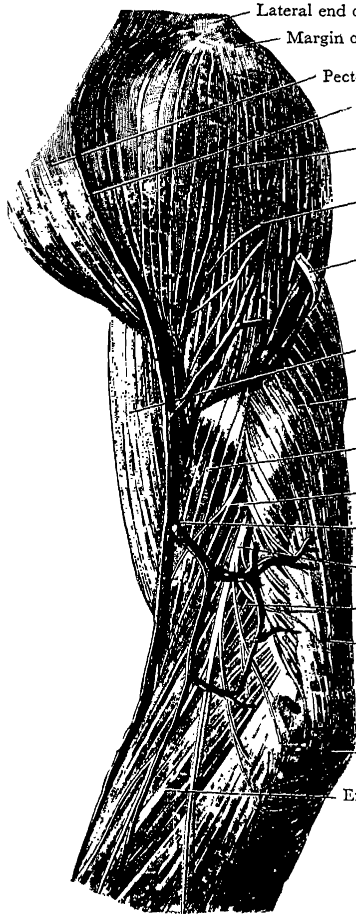


FIG. 34.—Deltoid Muscle and lateral aspect of Upper Arm.

Intermuscular Spaces.—The *quadrangular space* has no real existence until its boundaries are artificially separated from one another. These boundaries, as seen from the front, are the subscapularis above, the teres major below, the long

head of the triceps medially, and the surgical neck of the humerus laterally. At the back, the teres minor replaces the subscapularis as the upper boundary. Between the subscapularis and the teres muscles, *a loose fold of the capsule of*

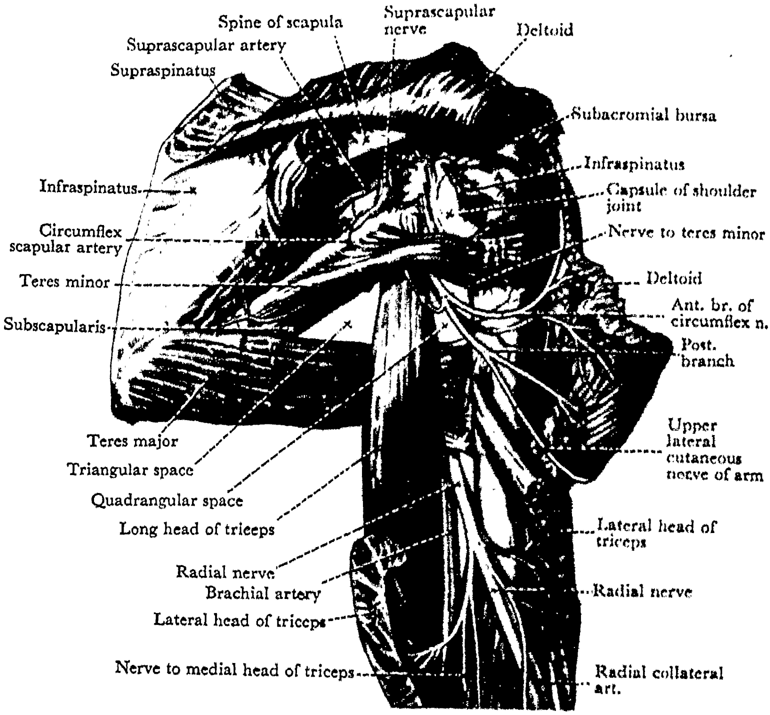


FIG. 35.—Dissection of Scapular Region and Back of Upper Arm. The lateral head of Triceps has been divided and turned aside to expose the spiral groove on the Humerus for the Radial Nerve.

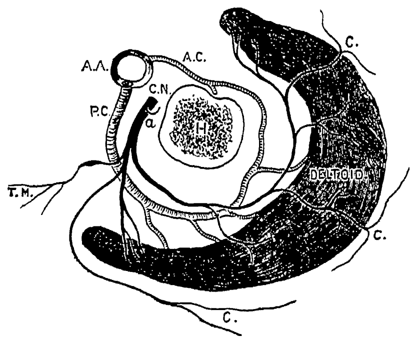
the shoulder joint appears in the upper boundary of the space (Fig. 48). The circumflex nerve and the posterior humeral circumflex vessels pass backwards through the space, directly below the capsule.

The *triangular space* (Fig. 35) is of less importance.

Circumflex Humeral Arteries.—The *posterior circumflex humeral artery* was seen in the axilla (p. 44),

springing from the axillary artery a short distance below the subscapular branch. It at once passes backwards through the quadrangular space, and, winding round the surgical neck of the humerus, it is distributed in numerous branches to the deep surface of the deltoid muscle. Several twigs are given also to other muscles, to the shoulder joint, and to the skin. It anastomoses with neighbouring arteries, the most important anastomosis being effected by a branch which it sends down to the profunda branch of the brachial artery.

The *anterior circumflex humeral artery* was described on p. 44. It is much smaller than the posterior circumflex



H. Transverse section of humerus immediately below the tubercles.
A.A. Axillary artery.
P.C. Posterior circumflex humeral artery.
A.C. Anterior circumflex humeral artery.
C.N. Circumflex nerve.
a. Articular branch.
T.M. Branch to teres minor.
C. Cutaneous branches.

FIG. 36.—Diagram of Circumflex Arteries and Nerve.

artery. By the anastomosis of their branches, an arterial circle is formed around the surgical neck of the humerus.

Circumflex Nerve (C. 5, 6).—This nerve supplies:—(1) an *articular twig* to the capsule of the shoulder joint; (2) *muscular branches* to the deltoid and teres minor; and (3) *cutaneous branches* to the skin over the lower half of the deltoid.

It springs from the posterior cord of the brachial plexus, turns round the lower border of the subscapularis, and passes backwards, with the posterior humeral circumflex vessels, through the quadrangular space to the back of the limb. There, it divides into an anterior and a posterior branch.

The *articular twig* takes origin from the trunk of the nerve in the quadrangular space, and enters the joint from below.

The *posterior branch* gives off the nerve to the teres minor, and, after furnishing a few twigs to the posterior part of the

deltoid, curves round its posterior border as the *upper lateral cutaneous nerve of the arm*, which runs forwards branching to supply the skin over the lower half of the deltoid (Figs. 33-36).

The *anterior branch* proceeds round the humerus with the posterior circumflex artery, and ends near the anterior border of the deltoid. It is distributed to the deltoid by numerous branches which enter the muscle through its deep surface and send a few fine filaments through it to the skin.

Dissection.—Clean the coraco-acromial ligament, which extends from the coracoid process to the acromion. First, examine the pectoralis minor and see whether or not its tendon sends a slip through the ligament to the capsule of the shoulder joint.

Coraco-Acromial Ligament and Arch.—The *coraco-acromial ligament* is a strong, flat band of a triangular shape. Its base is attached to the lateral border of the coracoid process ; its apex is attached to the extremity of the acromion (Figs. 49, 50, 52). Its upper surface is covered by the deltoid. Its lower surface is related to the sub-acromial bursa, which separates it from the supraspinatus muscle.

The *coraco-acromial arch* should be examined at the present stage, in order that its relationship to the subacromial bursa and the supraspinatus may be appreciated. It is the arch which overhangs and protects the shoulder joint. It is formed by the coracoid process, the acromion, and the coraco-acromial ligament. It is separated from the shoulder joint by the subacromial bursa, the tendon of the supraspinatus, and the upper parts of the tendons of the infraspinatus and subscapularis.

The coraco-acromial arch plays a very important part in the mechanism of the shoulder; for, with the subacromial bursa, it might almost be said to form a secondary synovial socket for the humerus.

Dissection.—Clear away the subacromial bursa and clean the *supraspinatus*, following it laterally to the humerus and medially below the coraco-acromial arch and trapezius. Then, clean the fascia from the surface of the *subscapularis*, noting its multipennate arrangement, and examine the attachments of the *serratus anterior* (Fig. 22). Now, turn the limb and remove the fascia from the *infraspinatus* ; and define the origin of the *teres major*.

SCAPULAR MUSCLES.—Under this head we include four muscles that arise from the dorsal surface of the scapula and one that springs from the costal surface.

Supraspinatus.—The supraspinatus muscle arises from the medial two-thirds of the floor of the supraspinous fossa. From this origin the fibres pass laterally under the acromion and end in a short, stout tendon which is inserted into the top of the greater tubercle of the humerus (Fig. 44, p. 104).

The supraspinatus is covered by the trapezius, the coraco-acromial arch, and the deltoid; and its tendon is closely adherent to the capsule of the shoulder joint.

It is supplied by the *suprascapular nerve*; and it is an abductor of the arm. It shares with the other scapular muscles the important function of maintaining the head of the humerus in the glenoid cavity during movements produced by muscles inserted farther from the shoulder joint.

Infraspinatus.—This muscle arises from the floor of the infraspinous fossa. Its tendon is closely adherent to the capsule of the shoulder joint, and is inserted into the greater tubercle behind the supraspinatus (Fig. 46, p. 109). Its lateral part is covered by the deltoid. Occasionally there is a small bursa between its tendon and the capsule of the shoulder joint, and, if present, it may communicate with the joint-cavity. This muscle is supplied by the *suprascapular nerve*; it is a lateral rotator of the arm, and it helps to steady the head of the humerus during abduction by the deltoid and supraspinatus.

Teres Minor.—This small muscle lies along the lower border of the infraspinatus. It arises from an elongated, flat impression on the dorsum of the scapula along the lateral border (Fig. 37). It is inserted by tendon into the back of the greater tubercle of the humerus, and also, by fleshy fibres, into the shaft below the tubercle for half an inch (Fig. 47). As it approaches its insertion it is separated from the teres major by the long head of the triceps brachii, and it is adherent to the capsule of the shoulder joint. The teres minor is supplied by a branch from the *circumflex nerve*. It is an adductor and lateral rotator of the arm.

Teres Major.—This is an elongated, rounded muscle that arises from the oval surface on the dorsum of the scapula close to the inferior angle (Fig. 37). It is inserted into the medial lip of the intertubercular groove of the humerus

tendinous intersections attached to the ridges on the scapula. The fleshy fibres converge upon a stout tendon which is adherent to the capsule of the shoulder joint, and is inserted into the lesser tubercle of the humerus ; a few of the lower fleshy fibres, however, gain independent insertion into the shaft below the tubercle (Fig. 44).

The muscle passes to its insertion under an arch formed by the coracoid process and the conjoined origin of the short head of the biceps and the coraco-brachialis. The subscapularis is supplied by the *upper* and *lower subscapular nerves*. It is an adductor and medial rotator of the arm.

Dissection.—Pull the long head of the biceps out of the intertubercular groove. Separate the tendon of the latissimus dorsi from the anterior surface of the teres major, looking for an occasional small bursa between them and noting the fibrous slip which passes from the latissimus to the long head of the triceps (Fig. 13); then, follow the tendon of the latissimus to its insertion.

Insertions of Pectoralis Major, Latissimus Dorsi and Teres Major.—Now that the tendons of these muscles are fully exposed, the student should review their insertions (see pp. 32, 63 and 91). The fibrous slip that connects the lower margin of the latissimus to the fascia on the long head of the triceps is of interest as it represents a muscle, called the *dorso-epitrochlearis*, which is present in certain animals.

Dissection.—Depress the upper border of the subscapularis as it passes below the coracoid process, and expose the *subscapular bursa*. Inflate the bursa with a blowpipe, and notice that, as air is blown in, the capsule of the shoulder joint is distended. Open the bursa and examine the interior.

Subscapular Bursa.—This is a prolongation of the synovial membrane of the shoulder joint through a large aperture in the upper and anterior part of the fibrous capsule (Figs. 49, 50). It extends laterally between the subscapularis and the medial part of the capsule, and medially in front of the neck of the scapula and the root of the coracoid process. It facilitates the movement of the subscapularis over these parts.

Dissection.—Cut through the subscapularis vertically below the coracoid process, and detach the bursa from its deep surface. Turn the medial part of the muscle towards the medial border of the scapula, and note the anastomosis between the arteries on its deep surface. Turn the lateral portion towards the humerus,

detaching it carefully from the capsule of the shoulder, and examine its insertion.

Divide the supraspinatus medial to the coracoid process. Turn the medial part towards the medial border of the scapula, and dissect its nerve of supply. Turn the lateral part towards the humerus, forcing it beneath the coraco-acromial arch, but avoiding injury to the suprascapular nerve and vessels, which lie beneath it. As its tendon crosses the top of the shoulder joint, it must be carefully detached from the capsule.

Divide the infraspinatus medial to the lateral border of the spine of the scapula. Turn the medial part medially and dissect out the vessels and nerves from its deep surface. Follow the lateral part to its insertion, and, as it is displaced, take care not to injure the suprascapular nerve and vessels and the circumflex scapular vessels, which lie between it and the bone. As you separate it from the capsule of the shoulder joint, avoid injury to the capsule. If there is a bursa under the tendon, see whether it communicates with the joint or not.

Divide the teres minor where the circumflex scapular artery passes between it and the bone; turn its lateral part towards the insertion, avoiding injury to the capsule as you divide the adhesion between them.

Now, look for the *suprascapular ligament*, which bridges across the notch on the upper border of the scapula. Find there the suprascapular nerve and vessels. Clean them, following them down into the infraspinous fossa; but be careful not to injure the branches of the nerve.

Suprascapular Ligament.—The *suprascapular ligament* is a firm fibrous band that passes from the upper border of the scapula to the root of the coracoid process. It bridges across the suprascapular notch, converting it into a foramen; sometimes it is ossified. The suprascapular nerve passes backwards through the foramen, and the suprascapular vessels lie above the ligament.

Dissection.—Revise the arteries that run in relation with the borders and surfaces of the scapula, and dissect out the anastomoses between their branches.

Anastomosis around the Scapula.—An important and free anastomosis takes place between the branches of three arteries which lie in close relation with the scapula and send branches to both its surfaces (Fig. 40).

The relation of the **deep branch of the transverse cervical artery** to the medial border of the scapula has been seen already in the dissection of the back (p. 64).

The **suprascapular artery** arises in the root of the neck, runs laterally behind the clavicle, and descends to the upper border of the scapula under cover of the trapezius. It then

PLATE VII

FIG. 38A.—Radiograph of Shoulder of young man aged 18. Note the positions of Scapula and head of Humerus.

FIG. 38B.—Radiograph of same Shoulder—arm abducted to right angle. Note the change in positions of Scapula and head of Humerus.

[Facing p. 94

PLATE VIII

FIG. 39.—Radiograph of same Shoulder as in Fig. 38—arm fully abducted and raised above the head. Note that the movement of the Humerus has continued until the shaft is in line with the spine of the Scapula; note the further movement of the Scapula itself.

passes backwards over the suprascapular ligament, gives branches to the supraspinatus muscle, and descends through the spino-glenoid notch to end by ramifying in the infraspinatus.

The **subscapular artery** has been traced in the dissection of the axilla (p. 43). Its largest branch is the *circumflex*

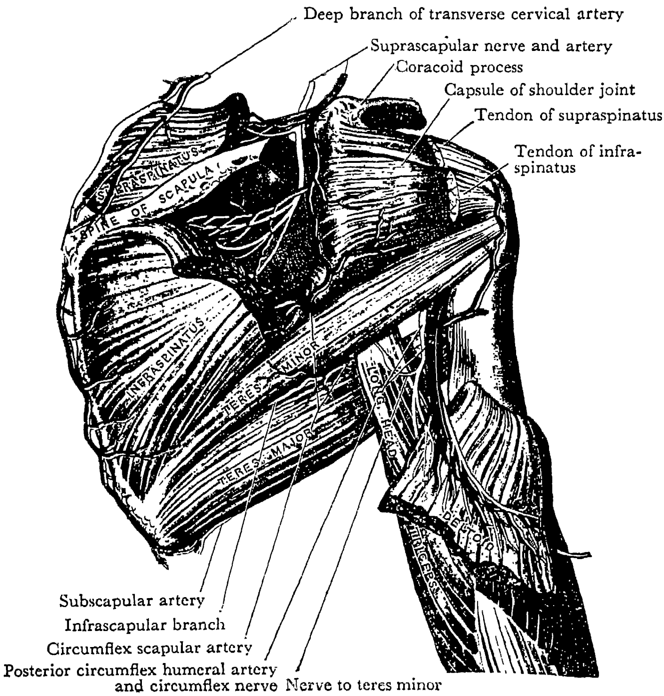


FIG. 40.—Anastomosing Arteries around the Scapula.

scapular artery, which sends branches into the subscapular fossa, and then runs under cover of the teres minor into the infraspinous fossa to ramify and anastomose there.

The arterial anastomosis around the scapula is very complete. The importance of the free communications between these arteries is manifest when it is realised that the suprascapular and the transverse cervical spring indirectly from the first part of the subclavian artery, and that the

subscapular arises from the third part of the axillary. When, therefore, a ligature is applied to any part of the great arterial trunk of the upper limb between the first stage of the subclavian and the third part of the axillary, the anastomosis around the scapula affords ample means of re-establishing the circulation.

Suprascapular Nerve.—This nerve arises from the fifth and sixth cervical nerves where they unite to form the upper trunk of the brachial plexus. It runs downwards and backwards in the neck, above the brachial plexus, passes under cover of the trapezius a little above the clavicle, and descends, in company with the suprascapular vessels, to the upper border of the scapula. It then passes downwards and backwards through the suprascapular notch, below the suprascapular ligament, which separates it from the suprascapular vessels.

Having entered the supraspinous fossa, it gives one or two branches to the supraspinatus and filaments to the capsules of the acromio-clavicular and shoulder joints; it then descends through the spino-glenoid notch, under cover of a loose fascial band that stretches across it, to end in the infraspinatus, having given additional twigs to the shoulder joint.

LIGAMENTS THAT CONNECT CLAVICLE WITH SCAPULA.—These ligaments are the coraco-clavicular ligament and the capsular ligament of the acromio-clavicular joint.

Dissection.—Lift up the medial end of the clavicle to put tension on the *coraco-clavicular ligament.* Remove any parts of the deltoid and trapezius that conceal the ligament. Clean its surfaces and borders. Note that it is divisible into two parts. Look for a bursa between the two parts.

Next, remove the remains of the deltoid and trapezius muscles from the capsule of the *acromio-clavicular joint,* and clean the external surface of the capsule. Open the joint, and see if there is an *articular disc* inside it.

Coraco-Clavicular Ligament.—This is a powerful ligament which binds the lateral part of the clavicle to the coracoid process. It is incompletely divided into conoid and trapezoid parts that meet at an angle; the angle is open anteriorly, and often contains a small bursa that diminishes the friction between the parts when the ligament is twisted during movements of the shoulder-girdle.

The *conoid part* lies behind and medial to the trapezoid part. Its thick end is attached to the conoid tubercle of the

clavicle (Fig. 10). The pointed end is attached to the upper surface of the coracoid process where the process bends forwards from its root. The *trapezoid part* is flat, thick and obliquely placed. It is attached to the trapezoid ridge of the clavicle and to the upper surface of the coracoid process.

The coraco-clavicular ligament helps to prevent dislocation of the acromial end of the clavicle, and, to a certain extent, it limits the movements of the acromio-clavicular joint. It is therefore an accessory ligament of that joint. It is also the main medium by which the scapula and, indirectly, the other parts of the upper limb are suspended from the clavicle. If the clavicle is broken medial to the attachment of the ligament, the upper limb, as a whole, at once falls—a characteristic sign of this common variety of fracture.

Acromio-Clavicular Joint.—This is a synovial joint. The *fibrous capsule* is attached to the margins of the articular surfaces ; and its upper part is thickened to form the *acromio-clavicular ligament.* The cavity is usually partially divided by a wedge-shaped *articular disc* whose base is attached to the upper part of the capsule (Fig. 48).

The surfaces of the joint are ovoid and flat, and each slopes obliquely downwards and medially. The clavicle tends therefore to glide on to the upper surface of the acromion. The tendency is counteracted by the strength of the acromio-clavicular ligament and by the coraco-clavicular ligament.

The capsule of the joint is supplied by filaments from the circumflex, suprascapular and pectoral nerves.

Movements.—The only movements are slight gliding and rotatory movements. They occur in association with pivotal movements of the shoulder-girdle as a whole at the sterno-clavicular joint, and allow the scapula to remain in apposition with the chest wall in different positions of the girdle. (*See also* Movements at the Shoulder Joint, p. 119.)

FRONT OF UPPER ARM

With this region it is convenient to study at the same time the cubital fossa in front of the elbow.

The deep fascia is already exposed and has been partly examined. Before proceeding to investigate the deeper connexions of the deep fascia, it may be well to review its general characters (p. 82) and the surface-anatomy of the upper arm and the elbow (p. 66).

Dissection.—(1) Cut through the deep fascia along the borders of the bicipital aponeurosis, so as to leave the aponeurosis in position. (2) Make a longitudinal incision through the deep fascia along the middle line of the biceps. (3) At the level of the epicondyles, make a transverse incision. (4) Reflect each of the two longitudinal flaps to its own side. As the reflexion proceeds it will become evident that four septa pass from the deep surface of the deep fascia between the various muscles.

Septa of Deep Fascia.—A loose septum passes transversely from side to side between the biceps and the muscle that lies behind it—the brachialis—(Figs. 41, 42); the musculo-cutaneous nerve is embedded in it. Another septum dips backwards to separate the brachialis from the muscles that spring from the lateral epicondylar ridge; embedded in it there are the radial nerve and a small artery. But the strongest and most important septa are the *lateral* and *medial intermuscular septa*, which connect the investing layer of the deep fascia with the margins of the humerus, and, together with the humerus, divide the upper arm into two osteo-fascial *compartments*—an *anterior* and a *posterior* (Figs. 41, 42). These two septa will be examined more fully after the back of the upper arm has been dissected (p. 112).

Anterior Compartment of Upper Arm.—This compartment has been opened by the reflexion of the deep fascia; it contains muscles, nerves and vessels, and their relative positions should be examined at once.

The *biceps brachii* is the most anterior muscle; the *brachialis* is under cover of its distal half and is closely applied to the front of the humerus; and the *coraco-brachialis* lies along the medial side of the proximal half of the biceps. The *brachio-radialis* and the *extensor carpi radialis longus* lie in the distal part of the compartment along the lateral side of the brachialis, to which they are closely applied; the brachio-radialis is the upper and the anterior of the two. The *brachial vessels* traverse the whole length of the compartment, in relation with the medial border of the biceps. The *median nerve* also runs through the whole length of the compartment, lying lateral to the brachial artery in the proximal half, and medial to it in the distal half. The *basilic vein* enters the compartment at the middle of the upper arm, where it pierces the deep fascia; it then ascends along the medial side of the brachial artery.

Dissection.—Fix the axillary artery and the nerves to the coracoid process again, and proceed to clean the brachial artery and its branches, its venæ comitantes, the proximal part of the basilic vein, and the accompanying nerves.

The artery should be disturbed as little as possible before its relations are studied. Therefore clean the nerves and the veins first, and take care not to injure the branches of the artery.

Begin with the *medial cutaneous nerves of arm and forearm*; and trace them to the points where they pierce the deep fascia.

Clean the *basilic vein* and push it forwards. Pick up the *ulnar nerve*, and follow it downwards till it pierces the medial intermuscular septum. Next, follow the *median nerve* to the front of the elbow; and then clean the *venæ comitantes* of the brachial artery, following them up to the axillary vein. At the same time, clean the *brachial artery*, dividing the cross-channels that connect its venæ comitantes as required.

Push the upper part of the brachial artery forwards, to get at the *radial nerve*. Follow the nerve to the upper end of the *radial groove of the humerus*, and follow the branches which it gives off before it disappears.

Now, turn to the branches of the brachial artery. Pick up each of them in turn, and clean it. The named branches spring from its medial side or from the back of it (see p. 103).

Median Nerve.—The median nerve arises in the axilla by two roots—one from the medial cord of the brachial plexus and one from the lateral cord. The nerve, thus formed, descends along the lateral side of the distal part of the axillary artery and the proximal half of the brachial artery as far as the insertion of the coraco-brachialis; there, it crosses in front of the brachial artery (sometimes behind) and descends along its medial side to the bend of the elbow, where it enters the forearm. It gives off no branches either in the axilla or in the upper arm.

Ulnar Nerve.—The ulnar nerve arises from the medial cord of the brachial plexus, and is its largest branch; occasionally the lateral cord contributes a slender root (passing behind the medial root of the median nerve) which brings fibres of the seventh cervical nerve to the ulnar nerve. Like the other large nerves that spring from the plexus, it arises opposite the lower border of the pectoralis minor, near the coracoid process. It descends, along the medial side of the third part of the axillary artery and of the proximal half of the brachial artery, to the insertion of the coraco-brachialis; it then leaves the brachial artery and, accompanied by the superior ulnar collateral artery, passes downwards and backwards through the medial intermuscular septum, into the posterior compartment (Fig. 42). In the posterior compartment

it descends, along the medial head of the triceps, to the back of the medial epicondyle. Do not follow it into the posterior compartment at present ; it will be dissected there at a later period. Like the median nerve, it gives off no branches while it is in the axilla and the upper arm.

Brachial Artery.—The brachial artery is the direct continuation of the axillary artery, and begins therefore at the lower border of the teres major; it passes downwards and

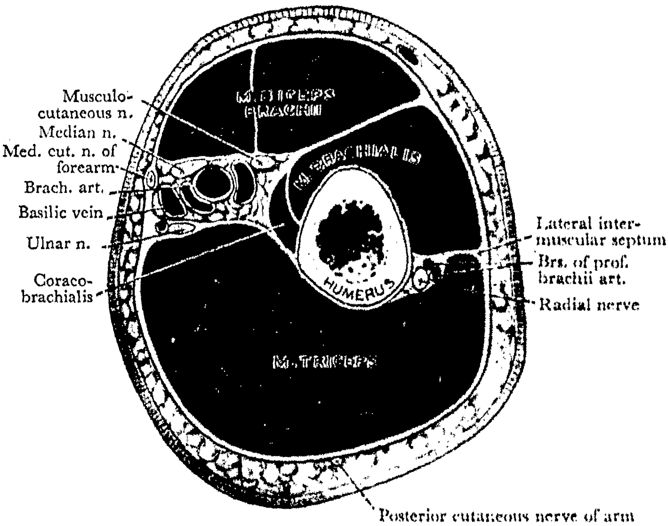


FIG. 41.—Section through the Middle of Right Upper Arm.

slightly laterally to the cubital fossa, where, at the level of the neck of the radius or slightly lower, it divides into its two terminal branches—the radial and the ulnar arteries (Figs. 45, 54, 81). In the proximal part of the upper arm, it lies to the medial side of the humerus, with the medial head of the triceps behind it (Fig. 41), but as it approaches the elbow it passes to the front of the bone and lies on the brachialis (Fig. 42).

This change of position must be borne in mind when pressure is applied to the vessel with the view of controlling the flow of blood through it. In the proximal part the pressure must be directed laterally and backwards, and in the distal part directly backwards.

Relations.—The brachial artery is superficial in the whole of its length. To expose it, you require to reflect only the skin and the fascia; but it is overlapped, from the lateral side, by the medial margins of the coraco-brachialis and biceps brachii (see Figs. 16, 41). At the bend of the elbow it is crossed superficially by the bicipital aponeurosis, which intervenes between it and the median cubital vein.

The basilic vein lies to the medial side of the artery, on a slightly more posterior plane. In the distal part of the arm,

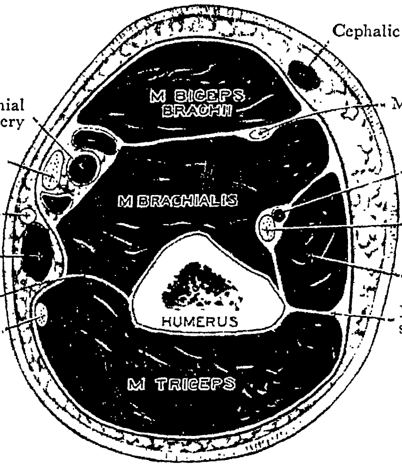


FIG. 42.—Section through the Distal Third of Right Upper Arm.

the vein is separated from the artery by the deep fascia; but in the proximal part, after the vein has pierced the fascia, it comes into closer relationship with the artery. The two venæ comitantes are closely applied to the sides of the artery, and the numerous connecting branches which pass between them, both in front of and behind the artery, make the relationship still more intimate.

The nerves related to the brachial artery are the median, the ulnar, the medial cutaneous nerve of the forearm and the radial. The relations of the median and ulnar nerves to the artery have just been mentioned (p. 99). The medial cutaneous nerve of the forearm is with the ulnar on the medial side of the artery as far as the insertion of the coraco-

brachialis; it then inclines forwards and medially to pierce the deep fascia. The radial nerve is behind the proximal inch of the artery, but it soon leaves it by passing downwards and laterally into the radial groove of the humerus, between the medial and the lateral heads of the triceps.

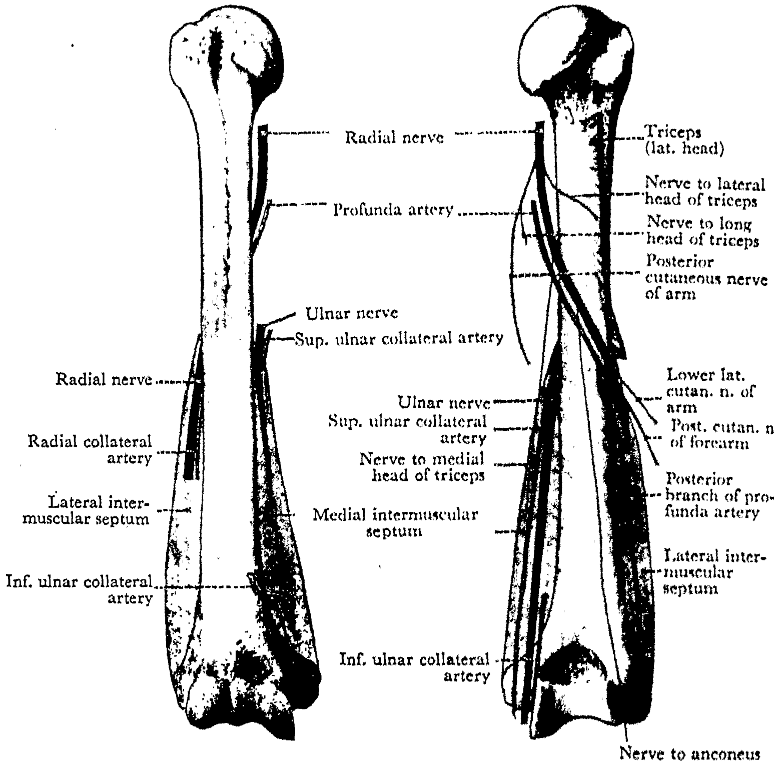


FIG. 43.—Diagram to show Relation of Radial Nerve to Humerus, and of Vessels and Nerves to the Intermuscular Septa.

Branches of Brachial Artery.—Several branches arise from the brachial artery. Those which arise from its lateral side are irregular in number, origin and size, and are distributed to the muscles and skin of the front of the arm. The named branches from the medial side and back of the parent trunk are as follows.

The *profunda brachii artery* is the largest branch. It takes origin high up and accompanies the radial nerve to the back of the arm (p. 112). Consequently, only a short part of the vessel is seen in the present dissection.

The *superior ulnar collateral artery* is a long, slender artery that accompanies the ulnar nerve to the back of the elbow.

The *nutrient artery* arises near the insertion of the coraco-brachialis and very soon disappears into the nutrient foramen of the humerus.

The *inferior ulnar collateral artery* arises about two inches above the bend of the elbow, and runs medially on the brachialis. It soon divides into an anterior branch and a larger posterior branch. The *anterior branch* is carried downwards in front of the medial epicondyle. The *posterior branch* pierces the medial intermuscular septum, and will be seen, at a later stage, in the posterior compartment of the arm.

Dissection.—Clean the *biceps brachii*, but do not injure the bicipital aponeurosis. Clean the *coraco-brachialis* ; separate it carefully from the short head of the biceps to find the *musculo-cutaneous nerve* as it leaves the coraco-brachialis; follow the nerve to the point where it emerges from behind the biceps, noting its branches to the biceps and brachialis and *the main arteries of supply that accompany them into the muscles*. Clean the *brachialis* as far as the bend of the elbow.

Musculo-Cutaneous Nerve.—This nerve arises from the lateral cord of the brachial plexus and inclines laterally to enter the deep surface of the coraco-brachialis a little below the pectoralis minor. It perforates the coraco-brachialis and descends obliquely between the biceps and the brachialis until it approaches the bend of the elbow, where it pierces the deep fascia at the lateral border of the tendon of the biceps. From that point, it has already been traced as the *lateral cutaneous nerve of the forearm* (p. 78).

The musculo-cutaneous nerve supplies branches to the coraco-brachialis, the biceps and the brachialis. The first is given off before the parent trunk enters the muscle ; the branch to the biceps springs from the trunk as it emerges from the coraco-brachialis ; and the branch to the brachialis arises as the trunk passes between that muscle and the biceps.

Coraco - Brachialis. — This fairly slender, rounded muscle takes origin from the tip of the coracoid process

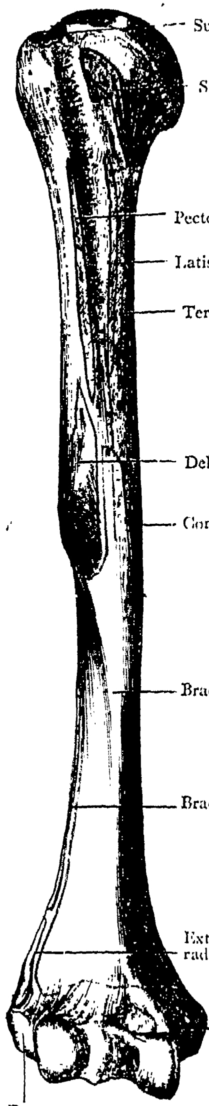


FIG. 44.—Front of Humerus with Muscular Attachments mapped out.

in conjunction with the short head of the biceps brachii. It descends along the medial margin of the biceps, and is inserted into the medial margin of the humerus about its middle. It is a flexor and adductor of the upper arm.

Biceps Brachii.—The biceps muscle arises from the scapula by two heads. The *short* or *medial head* springs from the tip of the coracoid process in conjunction with the coraco-brachialis (Fig. 22, p. 54). The *long* or *lateral head* is a rounded tendon which occupies the bicipital groove of the humerus. Its origin (from the supraglenoid tubercle of the scapula) cannot be studied at this stage, because it is within the shoulder joint. Both heads swell out into elongated fleshy bellies which are united in the distal third of the upper arm. Towards the bend of the elbow the fleshy fibres converge upon a stout, short tendon which is inserted into the posterior part of the tuberosity of the radius, an insertion that will be more fully examined later (p. 107). Notice, in the meantime, that a synovial bursa is interposed between the tendon and the anterior

part of the radial tuberosity, which is smooth in consequence.

The dissector has already taken notice of the *bicipital aponeurosis* (p. 82), and has separated it, artificially, from the deep fascia. Observe now that it springs from the tendon of the biceps, and also from the lower end of the short head; but tendinous fibres from each of the heads can be traced into it; and it is, in effect, an additional insertion of the muscle

The biceps brachii is supplied by the musculo-cutaneous nerve by a branch that divides to supply each head separately. It is a powerful supinator and, with the brachialis, a flexor of the forearm. It contracts also in flexion at the shoulder joint; but its principal function there is, by means of the tendon of the long head, to assist other muscles in retaining the head of the humerus in the glenoid cavity.

Brachialis.—The brachialis is a strong muscle that arises from the front of the distal half of the shaft of the humerus, embracing the insertion of the deltoid, and from the intermuscular septa. The fibres converge to be inserted into the front of the coronoid process of the ulna by a short, thick tendon. The muscle lies partly under cover of the biceps brachii but is seen also on each side of it. It is overlapped on its medial side by the pronator teres, and on the lateral side by the brachio-radialis and extensor carpi radialis longus. Its deep surface is closely connected to the anterior part of the capsule of the elbow joint.

Its chief nerve of supply, from the *musculo-cutaneous*, has already been secured; it enters by several twigs near the medial border, but the muscle receives also at its lateral border one or two small twigs (probably afferent) from the radial nerve given off under cover of the brachio-radialis. The brachialis is the primary flexor of the elbow joint.

Dissection.—**Separate the brachio-radialis from the brachialis muscle, and dissect out the *radial nerve* and its accompanying artery, which lie deeply in the interval between the muscles. Look also for the branches given by the nerve to the brachialis, brachio-radialis and extensor carpi radialis longus.**

Cubital Fossa

The cubital fossa is the hollow in front of the elbow. It corresponds to the popliteal fossa at the back of the knee.

It is triangular in outline, with the base above. The *roof* is the deep fascia strengthened by the bicipital aponeurosis

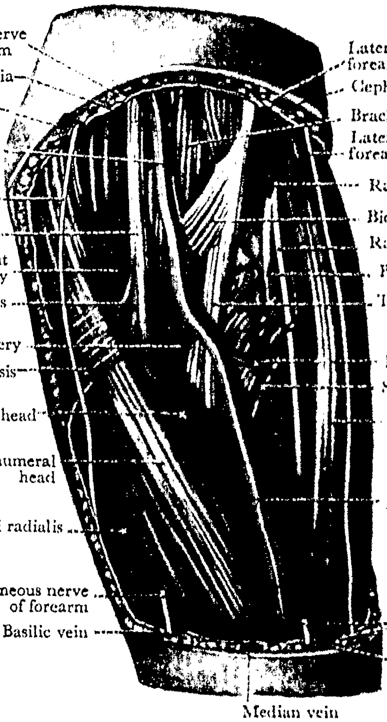


Fig. 45.—Dissection of Left Cubital Fossa.

(Figs. 32, 45); it is pierced by a communication between the deep veins and the median cubital vein. It is covered by the skin and by superficial fascia containing a portion of the cephalic vein, a portion of the basilic vein, the median cubital vein, the anterior branch of the medial cutaneous nerve of the forearm, and the lateral cutaneous nerve of the forearm.

The *base* is an imaginary line drawn between the two epicondyles. The *medial border* is the pronator teres muscle. The *lateral border* is the brachio-radialis. Those two muscles meet at the *apex*, where the brachio-radialis overlaps the pronator teres. The *floor* is formed by the distal part of the brachialis muscle and the anterior part of the supinator muscle, which is wrapped round the proximal third of the shaft of the radius.

The contents of the fossa are :—A quantity of fat ; the termination of the brachial artery ; the proximal parts of the radial and ulnar arteries ; the tendon of the biceps brachii, on the lateral side of the brachial artery ; and the median nerve, on the medial side of the artery.

The ulnar artery leaves the space by passing under cover of the pronator teres ; the radial artery descends through the apex of the fossa, overlapped by the brachio-radialis. The median nerve, having given off branches to the muscles on its medial side, disappears between the two heads of the pronator teres. The tendon of the biceps brachii inclines backwards, between the two bones of the forearm, to reach its insertion.

Dissection.—Cut across the bicipital aponeurosis near the biceps (Fig. 45), open up the fossa by pulling aside its boundaries with hooks, and then proceed to clean its contents.

Follow the *median nerve* to the point where it disappears between the heads of the pronator teres, and secure the branches arising from its medial side (p. 133). Clean the *brachial*, *radial* and *ulnar arteries* ; if their venæ comitantes are in the way, remove them. Secure and clean the branches that arise from the radial and ulnar arteries in the fossa. Clean the *tendon of the biceps brachii* and follow it to its insertion. Look for its bursa and open it (p. 104).

To facilitate the cleaning of the floor and to expose structures which are not strictly contents of the fossa but lie under cover of its boundaries, bend the elbow slightly, and pull the boundaries of the fossa still wider apart. Find the *radial nerve*, and the anterior descending branch of the *profunda artery* at the level of the lateral epicondyle, between the brachio-radialis and the brachialis. Follow the nerve and its *posterior interosseous branch*, which disappears into the substance of the supinator, a muscle that appears to be wrapped round the proximal part of the radius (Fig. 45). The radial nerve descends into the forearm between the brachio-radialis and the supinator.

After the contents of the cubital fossa have been cleaned and their relative positions noted, turn to the dissection of the back of the upper arm.

BACK OF UPPER ARM

Revise the cutaneous nerves before proceeding with the dissection (see p. 77).

Dissection.—Make a vertical incision through the deep fascia as far as the olecranon, and a transverse incision from one epicondyle to the other, taking care not to injure the posterior cutaneous nerve of the forearm. Reflect the flaps of deep fascia until their continuity with the medial and lateral intermuscular septa is demonstrated. As the medial flap is reflected, avoid injury to the ulnar nerve and the artery which accompanies it. Clean the triceps muscle and define its attachments.

Triceps Brachii.—The triceps muscle occupies the entire posterior osteo-fascial compartment of the arm. It arises by a *long head* from the scapula, and by two shorter heads—*lateral* and *medial*—from the humerus. The fleshy fibres of the three heads join a common tendon which is inserted into the upper surface of the olecranon.

The superficial part of the muscle is, for the most part, formed by the long and lateral heads. The medial head is deeply placed ; but a very small portion of it appears superficially, above the elbow, on each side of the common tendon of insertion

The *long head* of the triceps arises, by a flattened tendon, from the infraglenoid tubercle of the scapula (Fig. 37).

The *two humeral heads* take origin from the back of the humerus ; and if it is borne in mind that no fibres arise from the radial groove and that the groove intervenes between the origins of the two heads, their relations will be easily understood.

The *lateral head* of the triceps arises from a rough strip that descends from the back of the greater tuberosity to the groove—and also from the fascial sheet that bridges across the groove for the protection of the radial nerve.

The *medial head* of the triceps arises from the whole of the back of the humerus below the radial groove, and from the intermuscular septa. The upper end of the origin, which is narrow and pointed, reaches the insertion of the teres major, and is seen better on the front of the limb than on the back. The origin gradually widens as the groove passes towards the lateral border of the humerus ;

and in its distal third it covers the whole width of the back of the humerus. The medial head of the triceps, therefore, has very much the same origin from the back of the bone that the brachialis has from the front (cf. Figs. 44 and 46).

The *common tendon* is inserted into the back part of the upper surface of the olecranon and into the fascia that covers the anconeus muscle, which lies at the lateral side of the olecranon. Some of the short, fleshy fibres of the medial head are attached directly to the olecranon, and a few of them are inserted into the posterior part of the capsule of the elbow joint. A small bursa, which lies on the top of the olecranon, separates the common tendon from the posterior ligament of the elbow joint.

The triceps is supplied by branches from the *radial nerve*. It is a powerful extensor of the elbow joint and, by virtue of its long head, takes part also in movements at the shoulder joint.

Dissection.—To expose the radial nerve and the profunda brachii artery fully, divide the lateral head of the triceps. The handle of a seeker thrust along the radial groove deep to the muscle will give the direction in

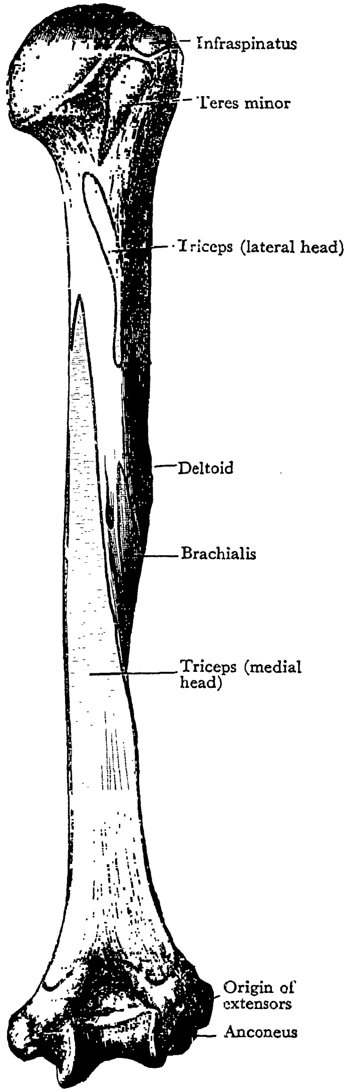


FIG. 46.—Back of Humerus with Muscular Attachments mapped out.

which it should be severed. Beyond cleaning the nerve and its branches and the profunda brachii artery, as they lie in the groove, no further dissection is necessary.

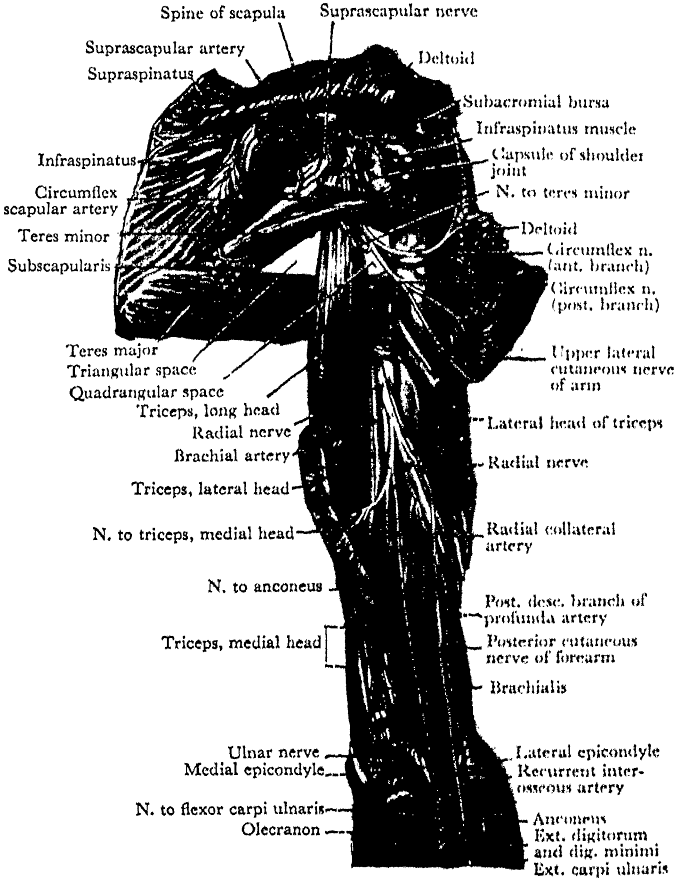


FIG. 47.—Dissection of Back of Shoulder and Upper Arm. The lateral head of Triceps has been divided and turned aside to expose the spiral groove on the Humerus for the Radial Nerve.

Radial Nerve.—The radial nerve is a terminal branch of the posterior cord of the brachial plexus. It is the thickest branch of that plexus; and, like the ulnar and median nerves, it extends from the axilla to the hand. The radial nerve at first descends behind the third part of the axillary artery and

the proximal part of the brachial artery. But it soon leaves the front of the arm in the interval between the long and the medial heads of the triceps, and enters a shallow groove on the back of the humerus. In that groove (*sulcus n. radialis*), it passes round the back of the humerus, under cover of the lateral head of the triceps ; and, on the lateral side of the limb, it pierces the lateral intermuscular septum and passes into the anterior compartment of the arm, where it has been dissected already. There, it lies deeply, in the interval that separates the brachialis from the brachio-radialis and extensor carpi radialis longus. At the level of the lateral epicondyle of the humerus, it gives off the posterior interosseous nerve (deep branch), and then descends (superficial branch), in front of the lateral part of the elbow joint, into the forearm.

Branches.—The branches which proceed from the radial nerve are ***muscular***, ***cutaneous***, and ***articular***.

The *cutaneous branches* have already been traced. They are :—(1) the posterior cutaneous nerve of the arm, (2) the lower lateral cutaneous nerve of the arm, and (3) the posterior cutaneous nerve of the forearm.

The superficial part of the radial nerve which is continued into the forearm is cutaneous ; but it does not pierce the deep fascia till it approaches the wrist ; and its distribution is to the skin of the back of the hand and the digits (p. 80).

The *muscular branches* are distributed to the three heads of the triceps, to the anconeus, to the lateral fibres of the brachialis, to the brachio-radialis, and to the extensor carpi radialis longus. The branches to the three last-named muscles spring from the trunk of the nerve after it has pierced the lateral intermuscular septum. The branch to the long head of the triceps arises in the axilla (p. 39) and pierces its anterior surface; those to the other heads of the triceps arise as the main nerve enters the radial groove. In addition, the medial head receives on its antero-medial surface a long, slender branch that runs with the ulnar nerve in the upper arm. The branch to the anconeus, also long and slender, reaches the muscle through the substance of the medial head of the triceps (Fig. 47).

The *articular branches* arise near the elbow, and supply the capsule of the elbow joint.

The *posterior interosseous nerve* has an extensive distribution to the muscles on the back of the forearm and to the radio-carpal and carpal joints. It will be dissected later.

Profunda Brachii Artery.—The profunda artery (p. 103) accompanies the radial nerve through the radial groove. Before it reaches the lateral intermuscular septum, it divides into two descending terminal branches—an anterior (*radial collateral artery*) and a posterior—which take part in the anastomoses around the elbow joint.

The other branches are distributed chiefly to the triceps; but a *nutrient artery* often springs from the profunda and enters the humerus through the floor of the radial groove. An ascending or *deltoid branch* which runs upwards between the long and lateral heads of the triceps to anastomose with the *posterior circumflex humeral artery*, is more important as it forms a link between the axillary and brachial systems of branches, and sometimes replaces the posterior circumflex (p. 89).

> ***Dissection.***—Trace the *ulnar nerve* and the *superior ulnar collateral artery* to the medial epicondyle. Clean also the posterior branch of the *inferior ulnar collateral artery*. Raise the tendon of the triceps, and look for the bursa that lies under cover of it.

Review the intermuscular septa, which are now fully exposed.

Medial and Lateral Intermuscular Septa. — The **medial intermuscular septum** is the stronger. It connects the investing deep fascia with the medial border of the humerus, and separates the medial head of the triceps from the brachialis, giving attachment to both muscles. It extends, as a strong membrane, from the medial epicondyle to the insertion of the coraco-brachialis. At the level of the insertion of the coraco-brachialis, it is pierced by the *ulnar nerve* which then descends behind it to the medial epicondyle, covered by a thin layer of fleshy fibres that belong to the medial head of the triceps (Figs. 41, 42).

The **lateral intermuscular septum** connects the deep fascia with the lateral border of the humerus. It extends from the lateral epicondyle to the insertion of the deltoid muscle. It separates the lateral part of the medial head of the triceps, which arises from its posterior surface, from three muscles that spring from its anterior surface—the brachialis, brachio-radialis and extensor carpi radialis longus. At the junction of the middle and distal thirds of the upper arm, it is pierced by the *radial nerve* (Figs. 41, 42).

SHOULDER JOINT

This is the time to dissect the shoulder joint, in order that the ligaments may be examined before they have become too dry.

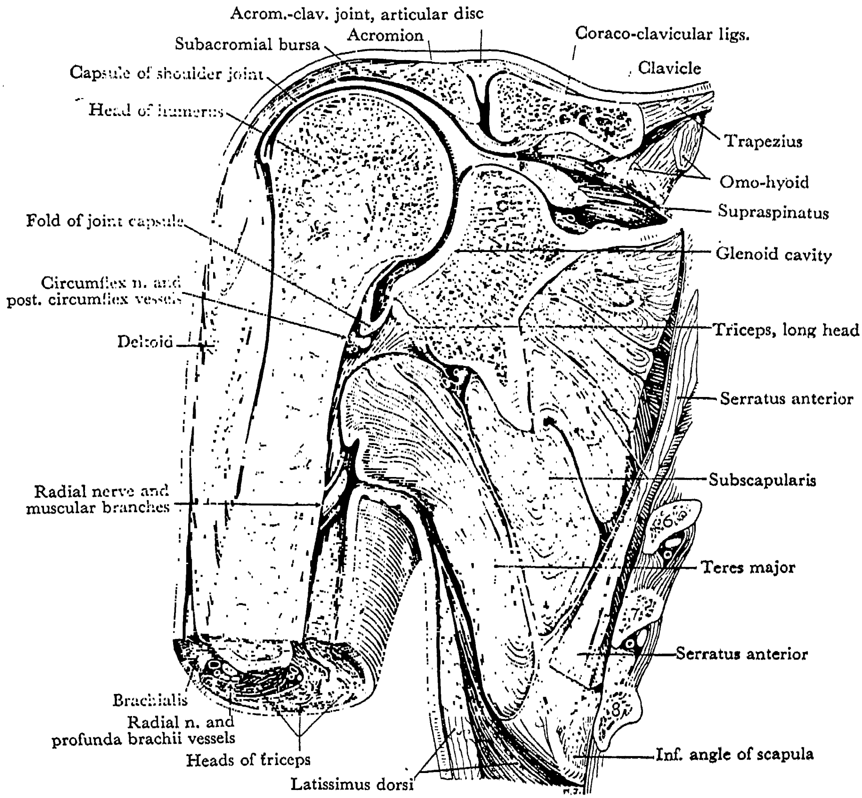


FIG. 48.—Coronal Section through Right Shoulder Joint. (Viewed from the front. Cf. Fig. 51.)

The shoulder joint belongs to the ball-and-socket group of synovial joints. The socket is the glenoid cavity of the scapula, and the ball is the head of the humerus.

In no joint in the body are the movements so free and so

varied as in the shoulder joint. This is necessary owing to the many functions performed by the upper limb. Freedom of movement is provided for in two ways—(1) by the large size of the head of the humerus, in comparison with the small, shallow glenoid cavity; (2) by the great laxity of the capsule of the joint. These provisions for allowing an extensive range of movement might, at first sight, lead one to doubt the

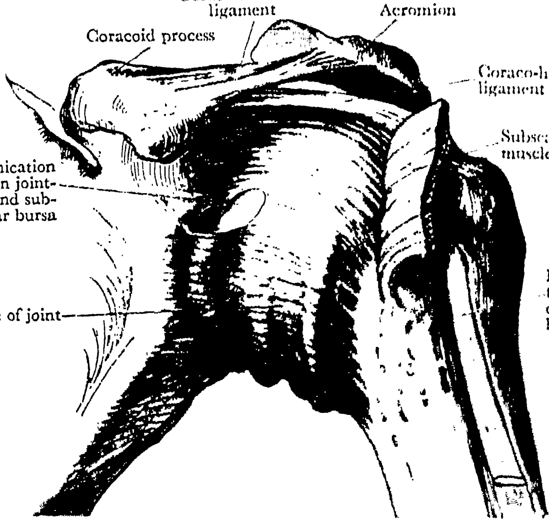


FIG. 49.—Front of Left Shoulder Joint.

security of the joint. Its strength certainly does not lie in the adaptation of the bony surfaces to each other, nor in the strength of its ligaments. It lies in:—(1) the powerful muscles by which it is closely surrounded; (2) the coraco-acromial arch, which overhangs it and forms, as it were, a secondary socket for the head of the humerus, and effectually prevents upward displacement; and (3) atmospheric pressure, which exercises a powerful influence in keeping the opposed surfaces in contact with each other.

On all aspects, except over a small area below, the capsule is supported by muscles, the tendons of which are more or less adherent to it. *Above*, it is covered by the supraspinatus; *behind*, the infraspinatus and teres minor are applied to it;

in front, there is the subscapularis—which is also below the capsule near the scapula (Fig. 50). *Below*, the capsule is otherwise unsupported by muscles, and there, in the ordinary dependent position of the limb, it bulges downwards, in the form of a fold, into the upper part of the quadrangular space (Figs. 48, 51). When, however, the arm is abducted, the fold is obliterated, and the head of the bone rests upon the inferior

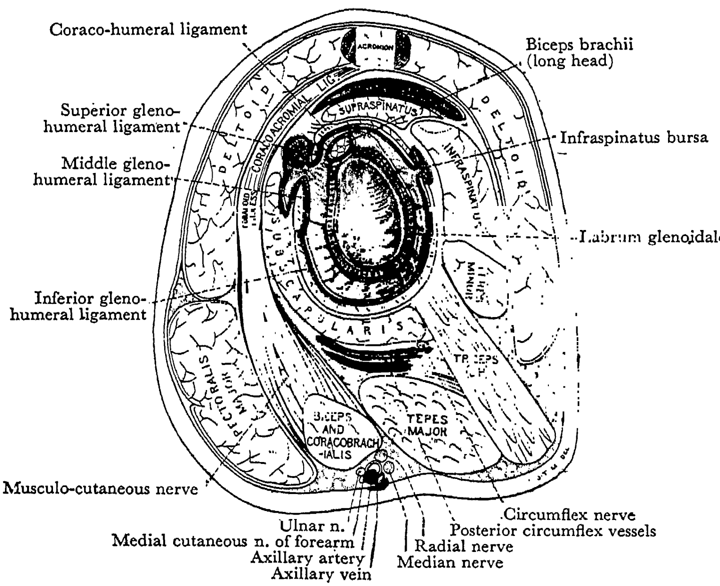


FIG. 50.—Dissection of Sagittal Section through Left Shoulder (semi-diagrammatic). The Subscapular Bursa protrudes between the superior and middle gleno-humeral ligaments.

part of the capsule, which now receives partial support from two muscles which are stretched under it, viz., the long head of the triceps and the teres major. Nevertheless, this is the weakest part of the joint; and dislocation of the head of the humerus downwards into the axilla, through the inferior part of the capsule, is consequently an occurrence of considerable frequency. When the dislocation occurs, the circumflex vessels and nerve may be injured, as they are close to the capsule (Figs. 48, 51).

Dissection.—The capsule of the shoulder joint was to a large extent exposed by the reflexion of the muscles inserted into the tuberosities of the humerus ; and the subscapular bursa has been examined.

To expose the capsule more fully :—Cut through the combined tendon of the coraco-brachialis and biceps, and displace the muscles downwards. Cut through the teres major about its middle and the long head of the triceps about one inch below its origin, and turn both muscles aside. Turn aside the reflected

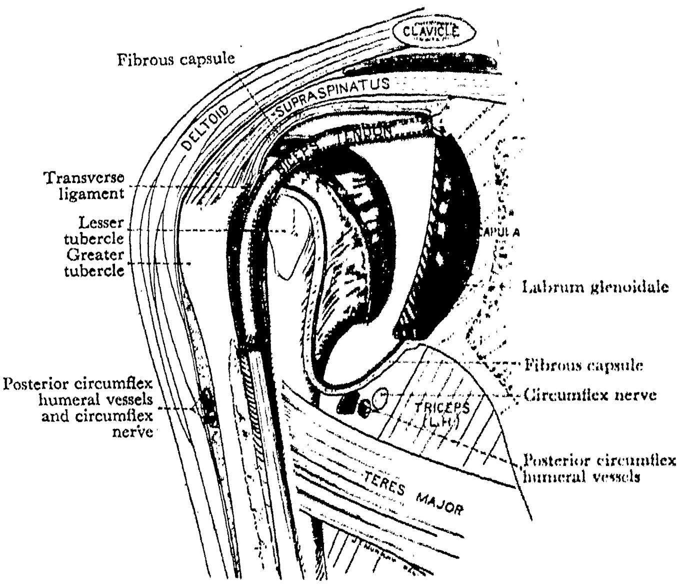


FIG. 51.—Diagram of Coronal Section of Right Shoulder. (Viewed from the front. Cf. Fig. 48.)

subscapularis, supraspinatus, infraspinatus and teres minor muscles, and note whether or not there is an aperture in the capsule between subscapularis and supraspinatus through which the subacromial bursa communicates with the joint.

Re-examine the subscapular bursa, and note that its aperture of communication with the joint is situated near the root of the coracoid process. Clean the outer surface of the capsule thoroughly. Note its laxity, and define its attachments.

Fibrous Capsule.—The fibrous capsule is a thin but fairly dense and strong tubular membrane which envelops the joint on all sides. It is attached to the scapula around the margin of the glenoid cavity, fusing with the outer surface

of a fibro-cartilaginous ring, called the labrum glenoidale, which is attached to the margin of the cavity for the purpose of increasing its depth. Laterally, the capsule is attached to the anatomical neck of the humerus and to the transverse ligament of the humerus, which bridges across the top of the intertubercular groove. The attachment of the upper part of the fibrous capsule to the humerus is quite close to the

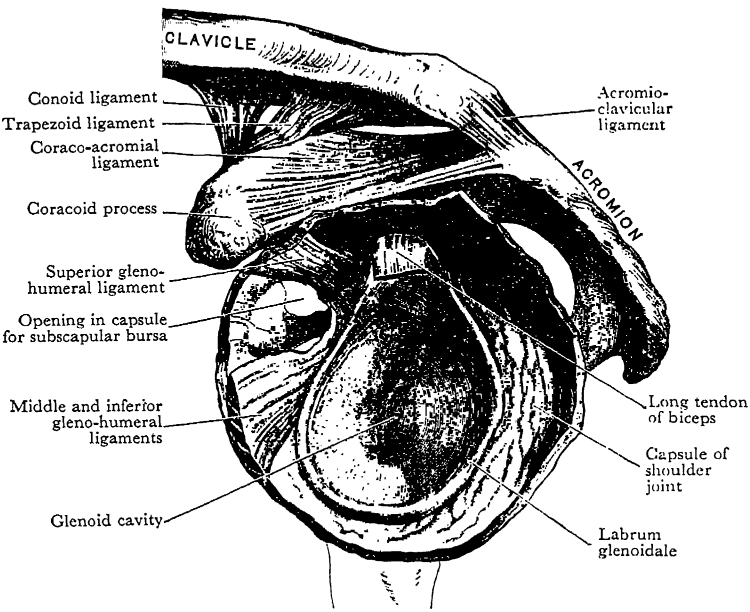


FIG. 52.—Left Shoulder Joint. The Articular Capsule has been cut across and the humerus removed.

articular surface of the head, but the attachment of the lower part is half an inch or more from the articular surface; consequently, a considerable part of the medial surface of the surgical neck is inside the fibrous part of the capsule, and is covered with the synovial membrane (Fig. 51). This cannot be seen until the capsule has been opened.

Apertures in Fibrous Capsule.—The fibrous capsule is not complete at all points. Its continuity is always broken by one aperture and sometimes by two more; and where its

lateral margin is attached to the transverse ligament, there is an aperture below the margin. Prolongations of the synovial membrane protrude through all the apertures.

The largest opening is in the antero-medial part near the root of the coracoid process; and the synovial membrane protrudes through it to form the *subscapular bursa*, which separates the subscapularis from the front of the capsule and from the front of the neck of the scapula. When the joint is dislocated, the head of the humerus is occasionally driven through this opening, instead of through the lower part of the capsule. It is not often that a second opening is found in the capsule. It is situated, when present, in the postero-lateral part of the capsule and permits the protrusion of the synovial membrane to form a bursa under the infraspinatus muscle (Fig. 50). Still more rarely, the subacromial bursa communicates with the cavity of the joint through an opening opposite the interval between the supraspinatus and subscapularis muscles.

The aperture below the transverse ligament, at the top of the intertubercular groove, transmits the tendon of the long head of the biceps; the tendon is enclosed in a tubular prolongation of the synovial membrane which surrounds it and lines the groove (Fig. 51).

Transverse Humeral Ligament.—This is an important retinaculum that holds the tendon of the long head of the biceps in place in the upper part of the intertubercular groove. It is attached to the two tubercles of the humerus, and bridges across the groove as far down as the level of the epiphysial line.

Accessory Bands.—The fibrous capsule is thickened in certain places by bands of fibres which pass from the scapula to the humerus. One of them—the *coraco-humeral ligament*—can be seen from the exterior; it is a wide, strong band on the upper surface of the joint, and is more or less completely incorporated in the capsule. The other three—the *gleno-humeral ligaments*—can be seen only from the inside, where they may raise ridges of synovial membrane.

The pectoralis minor occasionally sends a slip through the coraco-acromial ligament to fuse with the coraco-humeral ligament and, through it, to gain attachment to the humerus.

The *relations* of the capsule and the situation of these accessory bands are shown in Figs. 50, 51, 52.

PLATE IX

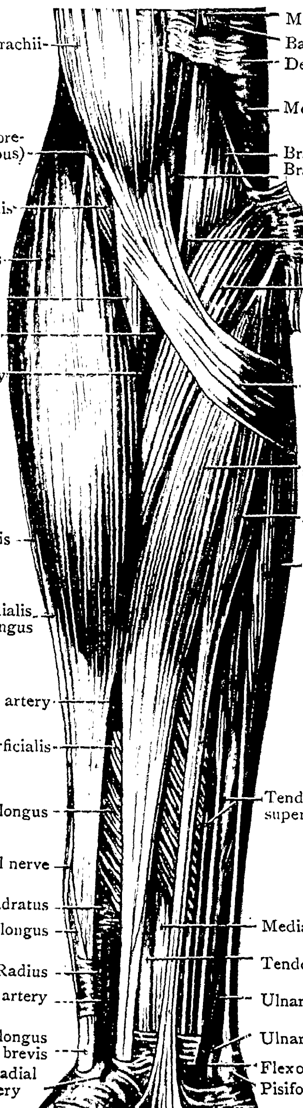


FIG. 53.—Dissection of Superficial Muscles, Arteries, and Nerves of Front of Forearm.

Part of the radial artery was removed to show some of its deep relations.

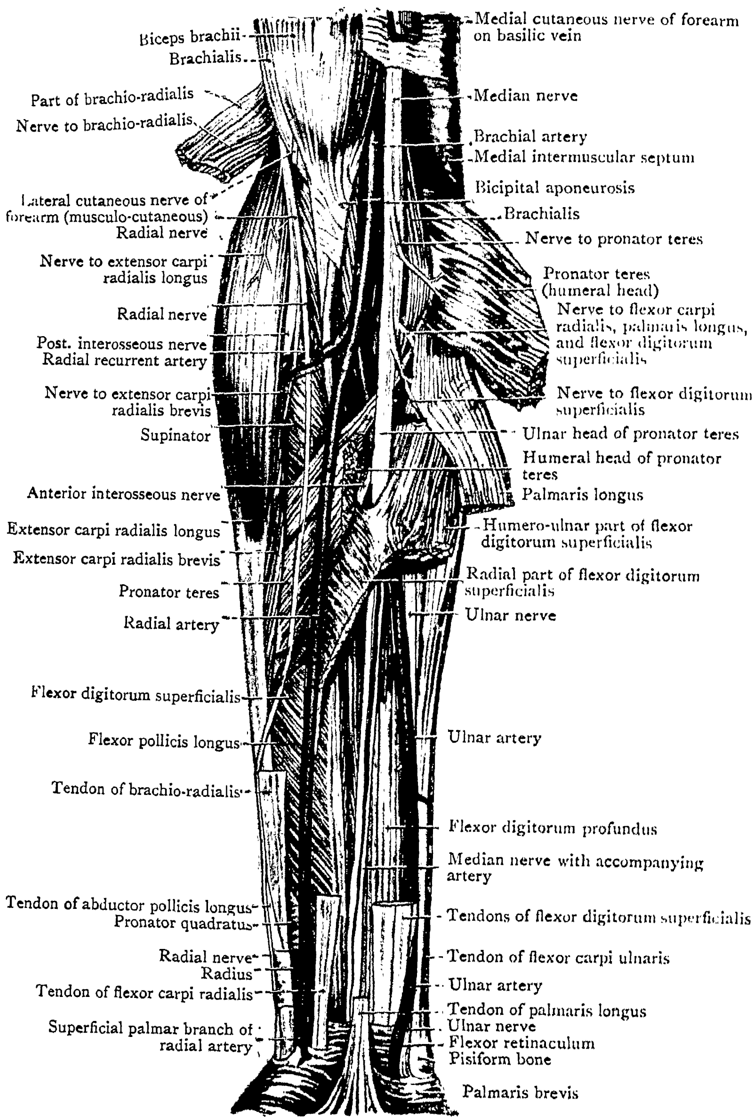


FIG. 54.—Deep Dissection of Muscles, Vessels, and Nerves of Front of Forearm. The division of the brachial artery is slightly lower than usual.

[*Facing p.* 119

Dissection.—**Make a vertical incision through the posterior part of the capsule. Turn the head of the humerus aside, and note if the gleno-humeral ligaments make their presence seen. Then, complete the division of the capsule, cut the long tendon of the biceps, and pull the humerus and scapula apart.**

Labrum Glenoidale.—The labrum is the dense, fibro-cartilaginous lip which is attached to the rim of the glenoid cavity and serves to deepen and widen the socket. Its intimate connexion with the capsule can now be studied.

Tendon of Long Head of Biceps.—This tendon is an important factor in the mechanism of the shoulder joint. Traced from below, it enters the joint through the opening between the two tubercles of the humerus, and is prolonged over the head of the bone to the apex of the glenoid cavity, where it is attached chiefly to the bone but partly blends with the labrum. By its position within the capsule and in the deep sulcus between the tubercles of the humerus, it serves to keep the head of the bone in place, and to steady it in the various movements at the shoulder joint.

Synovial Membrane.—The synovial membrane lines the fibrous capsule, and is reflected from it upon the neck of the humerus as far as the articular margin of the head. Its protrusion to form the *subscapular bursa* has already been noticed. The tendon of the biceps, as it traverses the joint, is enveloped in a sheath of the membrane; this sheath passes out with the tendon and lines the intertubercular groove (Fig. 51).

Articular Surfaces.—The cartilage of the head of the humerus is thickest in the centre and thins towards the edges. In the glenoid cavity the reverse of this will be seen, if the cartilage is incised.

Movements at the Shoulder Joint.—The shoulder is a ball-and-socket joint, and consequently movement in every direction is permitted, viz.—(1) *flexion*, or forward movement; (2) *extension*, or backward movement; (3) *abduction*; (4) *adduction*. By combination of the angular movements, *circumduction* is produced. The muscles inserted into the tuberosities act mainly in steadying and preventing displacement of the head of the humerus; while the main effectors of these movements are inserted farther from the joint. *Rotation* of the humerus, to the extent of quarter of a circle, occurs also.

The range of movement of the limb as a whole depends upon movements of the shoulder girdle, which are invariably associated with movements at the shoulder joint. In abducting the arm to the horizontal position, for example, and then raising it above the head, it is not the case that the humerus moves only in the first phase and the scapula in the second. The movements at shoulder joint and of shoulder girdle are associated throughout (Cathcart). Radiographs taken in different phases

of the action (Figs. 38, 39) demonstrate this association, and it has been shown that there is continuous movement of the scapula on the chest wall, and of the humerus at the shoulder joint (R. D. Lockhart). The movement of the humerus includes considerable lateral rotation (C. P. Martin), only if the arm is abducted at right angles to the trunk. If it is raised in the natural position in the plane of the scapula—a combination of pure flexion and abduction relative to the trunk—there is no rotation; and in that plane the arm can be easily raised much higher above the head (T. B. Johnston).

FOREARM AND HAND

Before proceeding with the dissection, review the surface-anatomy of the forearm and hand (p. 66), the arrangement of the superficial veins (p. 72), and the cutaneous nerves (p. 77).

Front and Medial Border of Forearm

In this dissection the structures to be displayed are the radial and ulnar arteries, the median, ulnar and radial nerves, and the group of pronator and flexor muscles.

Dissection.—Make two incisions through the deep fascia: (1) a transverse incision along the upper border of the flexor retinaculum; (2) a longitudinal incision from the apex of the cubital fossa to the transverse incision.

As the transverse incision is made, be careful not to injure the structures that are immediately subjacent to the deep fascia.

Turn the two flaps to the sides, dividing the septa which pass from their deep surfaces between the adjacent muscles. Both flaps can be reflected to the posterior border of the ulna, but, for the present, do not reflect the lateral flap beyond the radial border of the forearm. Near the elbow, where the muscles gain additional origin from the fascia, leave the fascia *in situ*, for attempts to remove it will result only in laceration of the muscles.

Muscles of Front of Forearm.—These muscles are the flexors of the wrist and digits and the pronators of the forearm, and are arranged in a superficial and a deep group.

In the *superficial group*, there are the pronator teres, the flexor carpi radialis, the palmaris longus, and the flexor carpi ulnaris (in that order from the lateral to the medial side), and also the flexor digitorum superficialis, which, however, is in a deeper plane, and comes to the surface only partially.

Identify these five muscles at once by reference to Fig. 53; they extend distally from the medial epicondyle. The pronator teres ends at the middle of the radius. The flexor carpi

radialis passes to the medial part of the ball of the thumb, and disappears there. The palmaris longus (if present) lies close along the medial side of the flexor carpi radialis. The flexor carpi ulnaris descends along the medial border of the forearm to the pisiform bone. The main part of the flexor digitorum superficialis is under cover of the other muscles, but

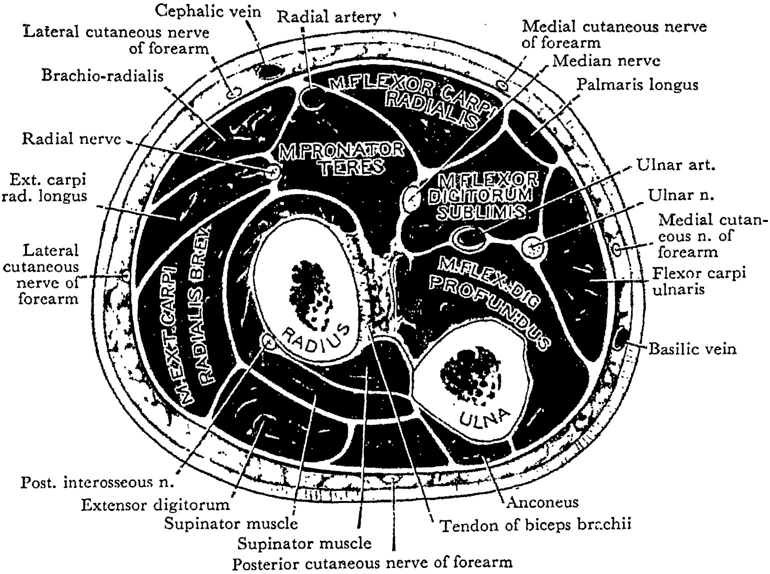


FIG. 55.—Section through Upper Third of Left Forearm.

in the distal part of the forearm, part of it appears between the palmaris longus and the flexor carpi ulnaris.

The *deep group* is composed of three muscles, placed in contact with the bones and interosseous membrane, viz., the flexor digitorum profundus in relation to the ulna, the flexor pollicis longus in relation to the radius, and the pronator quadratus closely applied to the distal parts of both bones.

The *brachio-radialis* muscle, though it belongs to the extensor group (p. 152), lies in the lateral part of the *front* of the forearm and is functionally a flexor of the elbow (see p. 156). It extends from the lateral supracondylar ridge of the humerus to the distal end of the radius and it should be

dissected at this stage with the radial artery and the radial nerve. Its description will be found with the other members of its group (p. 156).

Dissection.—Clean the *brachio-radialis* from end to end. Two muscles overlie its distal part—the abductor pollicis longus and extensor pollicis brevis. Push them aside, taking care not to injure the radial nerve. Having cleaned the brachio-radialis, pull it aside and clean the *radial nerve* and the *radial artery* and its branches.

Radial Artery.—This is the smaller of the two terminal branches of the brachial artery, but its direction gives it the appearance of being the continuation of the parent trunk in the forearm. It takes origin in the cubital fossa opposite the neck of the radius, and it descends in the lateral part of the front of the limb until it reaches the distal end of the radius. There, it turns round the lateral border of the wrist and leaves the present dissection (Figs. 57, 81).

Relations in Forearm.—Throughout its whole length it is closely accompanied by *venæ comitantes.* At first, it lies between the pronator teres and the brachio-radialis, and is overlapped to a variable extent on the lateral side by the fleshy belly of the brachio-radialis (Fig. 53). Lower down, the brachio-radialis is on its lateral side, and the flexor carpi radialis on its medial side ; and so remain as far as the wrist. Where the muscles mentioned are fleshy, the artery lies at some depth from the surface ; but when their tendons appear it assumes a superficial position, and is covered merely by the skin and the fasciæ. The radial nerve lies along its lateral side in the middle third of the forearm ; higher up, the nerve is separated from the vessel by a slight interval ; and, distally, the nerve leaves the artery and turns round the lateral margin of the forearm, under cover of the tendon of the brachio-radialis.

Posteriorly, the radial artery rests chiefly on the muscles which clothe and find attachment to the front of the radius. At its origin, it rests upon the tendon of the biceps brachii ; and then, in succession, it lies in front of the supinator, with some adipose tissue intervening, the pronator teres, the radial head of the flexor digitorum superficialis, the flexor pollicis longus, the pronator quadratus, and, lastly, the distal end of the radius.

The radial artery is usually selected for feeling the *pulse*. When the tips of the fingers are placed upon the distal part of the forearm a little

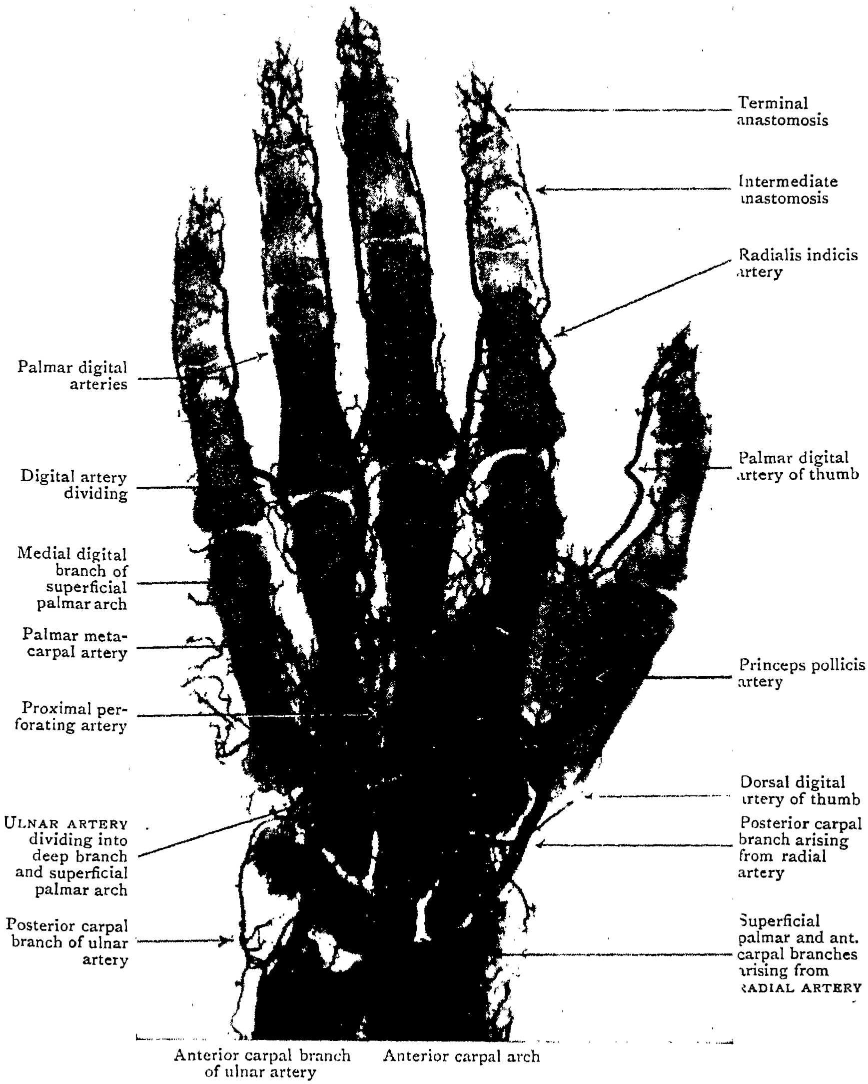


FIG. 56.—Radiograph of Hand in which the Arteries were injected with radio-opaque material (from positive print). Cf. Fig. 68. The superficial palmar arch is irregular and appears to be completed by a branch of the princeps pollicis artery.

[*Facing p.* 122

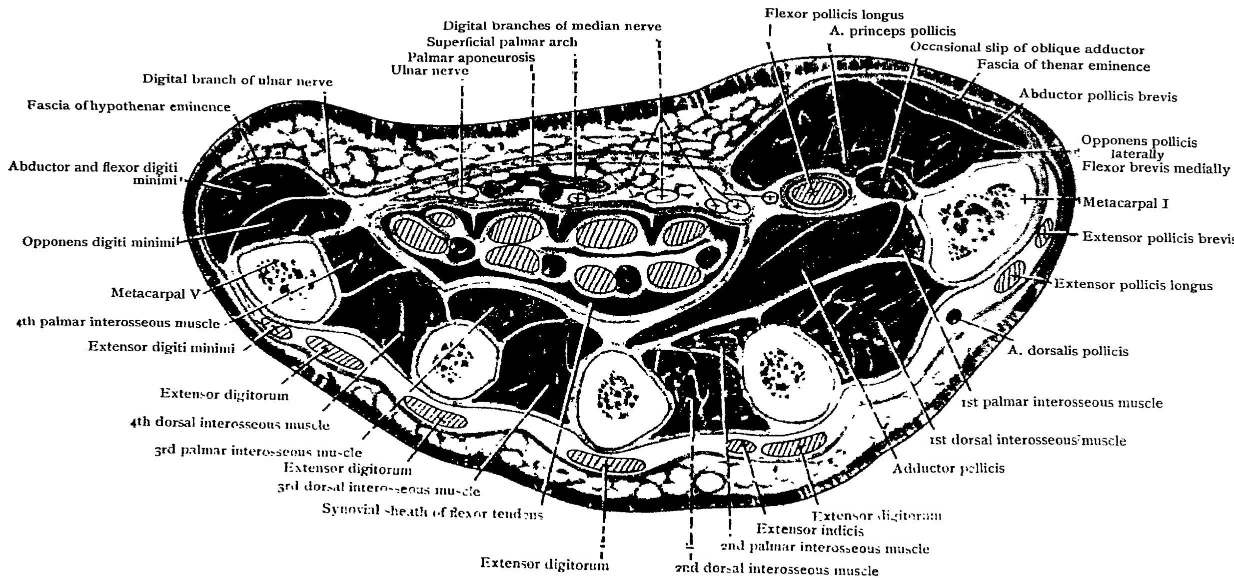


FIG. 57.—Oblique Cross-Section through the Hand, showing the Fascial Compartments.
The septa and fascial planes in the palm are emphasised in this illustration ; they are of much finer texture in the living hand.

lateral to the tendon of the flexor carpi radialis in the living person, the pulsations of the vessel can readily be felt.

Branches in Forearm.—The *muscular branches* are numerous; they arise at irregular points, mainly in the upper part of its course in the forearm (Figs. 54, 81).

The *radial recurrent artery* takes origin close to the beginning of the radial artery. It runs upwards to anastomose with the anterior branch of the profunda brachii artery in front of the lateral epicondyle.

The *superficial palmar artery*, small and variable, arises a short distance above the wrist, and ends in the thenar muscles. It may, however, continue into the palm and take part in forming the superficial palmar arch.

The *anterior carpal artery* is a small branch that runs medially on the distal end of the radius.

Radial and Posterior Interosseous Nerves.—The deep branch of the radial nerve springs from the main trunk at the level of the lateral epicondyle of the humerus and descends in front of the capitulum and lateral part of the head of the radius under cover of the brachio-radialis. It gives branches to the extensor carpi radialis brevis and the supinator, and then disappears into the supinator to reappear in the back of the forearm as the *posterior interosseous nerve.*

The **radial nerve** leaves the upper arm by descending in front of the lateral part of the elbow joint. In the forearm, it lies for a great part of its course under cover of the brachio-radialis, coming into relation with the lateral side of the radial artery in the middle third of the forearm. In the distal third, it leaves the artery, inclines backwards, appears at the posterior border of the tendon of the brachio-radialis, pierces the deep fascia about two inches above the wrist, and descends across the abductor pollicis longus and extensor pollicis brevis into the hand, where it has been examined already. It gives off no branches in the forearm.

Dissection.—Before you begin to clean the superficial flexor muscles, make an attempt to demonstrate the synovial sheaths of the flexor tendons; their upper parts are under cover of the deep fascia above the flexor retinaculum. They are the common sheath of the superficial and deep flexors of the fingers, the sheath of the flexor pollicis longus and the sheath of the flexor carpi radialis.

If the sheaths are uninjured they can be distended with air by means of a blowpipe, or by liquid forced in through a

are double-walled tubes, with the space between the two walls —the so-called cavity of the sheath—closed at the ends. The cavity of the sheath is a capillary space only, and it

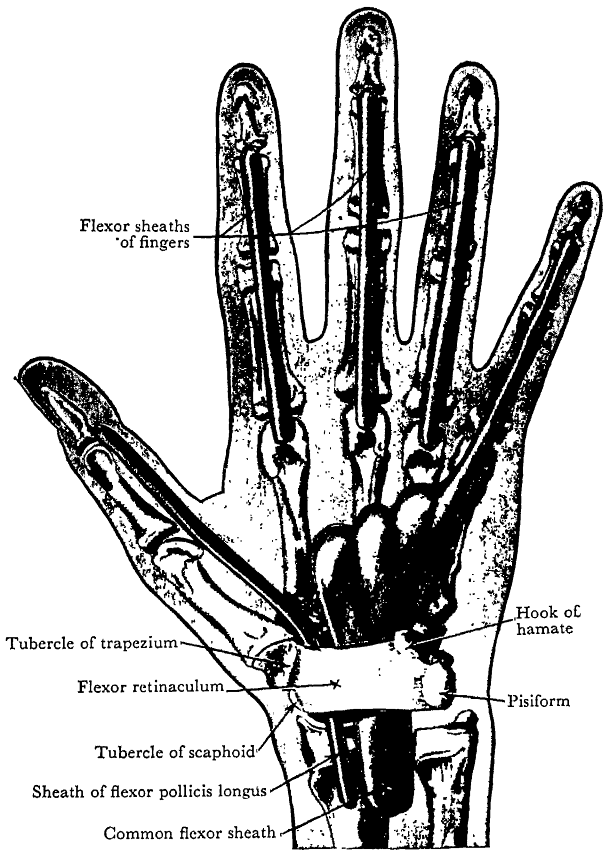


FIG. 58.—Synovial Sheaths of Flexor Tendons of Digits.

contains merely sufficient synovia to lubricate the surfaces, and facilitate their free play over one another.

The inner wall of the tube surrounds the tendon and adheres to its surface. The outer wall lines the canal through which the tendon passes, and adheres to it. The common sheath of the flexors of the fingers is a sac rather

than a tube; and it is invaginated by the tendons from the lateral side (Fig. 59).

When a sheath becomes inflamed the adjacent surfaces of its two walls are at first roughened, and when the tendon moves, there is friction and pain. When the fluid between the two walls increases in amount, the sheath becomes distended as if it had been injected, and its position becomes apparent. At the same time the friction ceases, but the distension of the walls, too, is painful as it stretches the nerves.

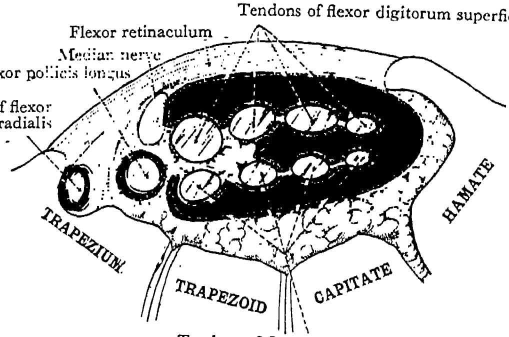


FIG. 59.—Diagram of Synovial Sheaths behind Flexor Retinaculum.

Dissection.—Clean the muscles that arise from the medial epicondyle, and be careful not to damage their nerves, which enter them (with the exception of the flexor carpi ulnaris) from the median nerve in the cubital fossa.

Begin with the *pronator teres*. Clean it from end to end, pushing aside the muscles that cover its insertion, and be careful not to injure the radial origin of the flexor digitorum superficialis, which lies behind its lower part. Separate the pronator teres from the flexor carpi radialis. Cut the head of the pronator that arises from the medial epicondyle. Turn the lower part downwards and find the deep head—a slender slip behind the median nerve—and follow it upwards to the coronoid process of the ulna.

Clean the *flexor carpi radialis* down to the flexor retinaculum; and clean the *palmaris longus* down to its insertion into the palmar aponeurosis. (The palmaris longus is sometimes absent.)

Now, clean the *flexor carpi ulnaris*—first down to the pisiform bone, and then upwards. In addition to its epicondylar origin, it has a thin, wide head that arises from the ulna. Find the ulnar nerve between the two heads at the elbow and, by separating the muscle from the palmaris longus and flexor digitorum superficialis, trace the nerve into the forearm and onwards to the wrist. Secure its branches to the flexor carpi ulnaris, which arise just below the elbow, and to the flexor digitorum profundus a little lower down; also the cutaneous branches (dorsal branch and palmar cutaneous

branch, p. 79) that arise from it in the lower half of the forearm. Clean the lower half of the *ulnar artery* (and its branches) as far as the wrist; its carpal branches, given off near the wrist, are very liable to injury.

To get a good view of the *flexor digitorum superficialis* :— Divide the palmaris longus and the flexor carpi radialis at the middle of the forearm ; turn their proximal parts upwards and separate them from the pronator teres and the superficial flexor by splitting the intervening intermuscular septa ; trace the median nerve to the point at which it disappears behind the flexor digitorum superficialis. Then, clean the muscle, being careful not to injure the part of it that arises from the radius, and its four tendons. Pull upon the tendons and note the results. Do not follow them farther than the flexor retinaculum at present.

SUPERFICIAL MUSCLES.—The five muscles of the superficial group are closely associated with each other at the elbow —indeed, they arise by a **common origin** from the front of the medial epicondyle. The pronator teres, the flexor digitorum superficialis, and the flexor carpi ulnaris, have secondary heads of origin (Figs. 53, 54).

Pronator Teres.—This muscle crosses the proximal half of the front of the forearm obliquely. It arises by two heads.

The *humeral head* constitutes the chief bulk of the muscle. It springs from the medial epicondyle and from the distal part of the medial supracondylar ridge. The *ulnar head* is a small slip placed deeply, and it may be recognised from the fact that it intervenes between the median nerve and the ulnar artery. It arises from the medial border of the coronoid process of the ulna (Fig. 61, p. 132), and soon joins the deep surface of the humeral head.

The muscle, thus formed, descends obliquely and ends in a tendon which gains insertion into a rough impression on the middle of the lateral surface of the radius (Fig. 61). This attachment is on the summit of the chief curve of the radius —an arrangement which enables the muscle to exercise its pronating action at great advantage. It is a pronator and flexor of the forearm, and is supplied by the *median nerve.*

Flexor Carpi Radialis.—The radial flexor of the wrist arises chiefly from the medial epicondyle. A short distance below the middle of the forearm, its fleshy belly gives place to a long tendon which, at the wrist, traverses the groove on the front of the trapezium in a special compartment at the lateral end of the flexor retinaculum (Fig. 59). It is inserted

chiefly into the base of the metacarpal bone of the index. Its relations to the flexor retinaculum, and also its insertion, will be exposed at a later stage of the dissection (p. 171).

It is a flexor of the wrist and elbow, and an abductor of the hand. It is supplied by the *median nerve.*

Palmaris Longus.—This long, slender muscle is not always present. Its tendon pierces the deep fascia immediately above the wrist, and then crosses the flexor retinaculum, adhering to it, to be inserted into the apex of the palmar aponeurosis. It is supplied by the *median nerve*; and it is a flexor of the wrist and elbow joints.

Flexor Carpi Ulnaris.—The ulnar flexor of the wrist arises by two heads. The *humeral head* arises from the medial epicondyle. The *ulnar head* arises from the olecranon and, by a wide *aponeurosis*, from the upper two-thirds of the posterior border of the ulna. The two heads of origin bridge across the interval between the medial epicondyle and the olecranon, and between them the ulnar nerve passes into the forearm. The tendon appears on the anterior border of the muscle, and is inserted into the pisiform bone.

The flexor carpi ulnaris is supplied by the *ulnar nerve.* It is a flexor and adductor of the hand and a flexor of the elbow.

Flexor Digitorum Superficialis.—This muscle receives its name because it is superficial to the flexor profundus; but for the most part it lies deeper than the other superficial muscles (Fig. 53). It is a powerful muscle which arises by two heads. The *humero-ulnar head* arises chiefly from the medial epicondyle and the coronoid process. The *radial head* is a thin sheet that arises from the upper half of the anterior border of the radius (Fig. 61).

Four tendons issue from the fleshy mass; they enter the palm by passing under cover of the flexor retinaculum, and go to the medial four digits to be inserted into the middle phalanx. Their insertions will be seen later; but, in the meantime, note that, for an inch above the wrist, they are enveloped by the synovial sheath, and also that they lie in pairs—the tendons to the ring and middle fingers being placed in front of those for the index and little fingers.

The flexor digitorum superficialis is supplied by the *median nerve.* It is a flexor of the first interphalangeal joints of

the fingers, the metacarpo-phalangeal joints, and the wrist joint.

Dissection.—Divide the radial head from the main mass of the flexor digitorum superficialis and separate the two portions. Detach the median nerve from the deep surface of the muscle, and trace it downwards. Secure its palmar cutaneous branch near the wrist, and look for a branch it may give to the lower part of the superficial flexor.

Clean the flexor pollicis longus and the flexor digitorum profundus, taking care of their nerves; and complete the cleaning of the ulnar artery.

Return to the median nerve in the cubital fossa. Trace its branches to neighbouring muscles. Follow it downwards and secure the anterior interosseous nerve, which springs from the median as it passes between the heads of the pronator teres. Find the *common interosseous artery*, which arises from the ulnar an inch below its origin, and soon divides into the anterior and posterior interosseous arteries. The posterior branch passes backwards out of this dissection. Separate the flexor pollicis and flexor profundus, and trace the *anterior interosseous artery* and *nerve* downwards to the pronator quadratus—taking care of the branches of the nerve. Clean the pronator quadratus.

Ulnar Artery.—This is the larger of the two terminal branches of the brachial trunk. It takes origin, in the cubital fossa, at the level of the neck of the radius (Fig. 81). In the upper third of the forearm it passes obliquely downwards and medially, and then it proceeds straight down to the wrist. It pierces the deep fascia immediately above the flexor retinaculum, and passes on to the front of it, where it gives off a *deep palmar branch* and then becomes the *superficial palmar arch* (Fig. 57).

Relations.—Throughout its entire course it is accompanied by two *venæ comitantes*. In the upper, oblique portion of its course, the vessel is deeply placed, and is crossed by both heads of the pronator teres, the flexor carpi radialis, the palmaris longus, the flexor digitorum superficialis and the median nerve (Fig. 54). Its lower, vertical part is overlapped medially by the flexor carpi ulnaris, but a short distance above the wrist it comes nearer the surface, and lies behind the deep fascia in the interval between the tendon of the flexor carpi ulnaris and the tendons of the flexor superficialis. It has important relations to the median and ulnar nerves (pp. 131, 133).

In the cubital fossa, the ulnar artery rests on the brachialis ; from there to the wrist, it lies on the flexor digitorum profundus ; at the wrist, it lies on the flexor retinaculum.

Branches of Ulnar Artery in Forearm.—In addition to *muscular branches*, there are several that are named.

The **ulnar recurrent arteries**, anterior and posterior, arise

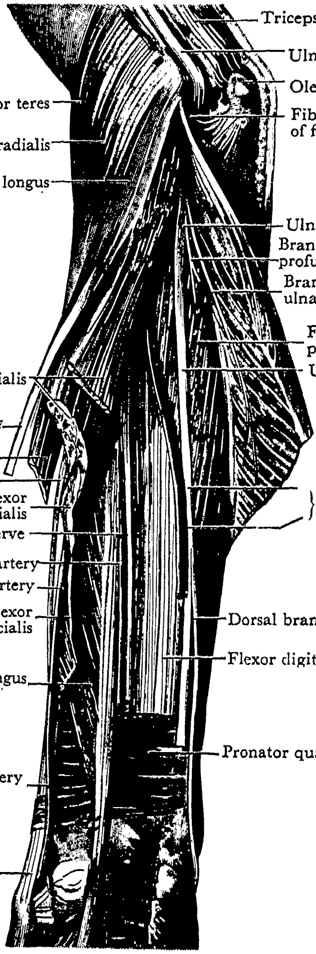


FIG. 60.—Deep Dissection of Front of Forearm.

The superficial muscles are cut short and turned aside. The deeper parts are still further displayed by the separation of the flexor digitorum superficialis from the flexor carpi ulnaris.

near the elbow and anastomose with branches of the brachial artery on the front and back of the medial epicondyle.

The **common interosseous artery** is a short, wide trunk which takes origin below the recurrent branches, about one inch from the commencement of the ulnar artery. It passes backwards to the upper margin of the interosseous membrane, where it divides.

The **posterior interosseous artery** passes backwards above the interosseous membrane to the back of the forearm, where it will be dissected at a later period.

The **anterior interosseous artery** descends over the front of the interosseous membrane, between the flexor pollicis longus and the flexor digitorum profundus. At the upper border of the pronator quadratus, it pierces the interosseous membrane and passes to the back of the forearm, where it will be seen later. In addition to *muscular* twigs, it supplies *nutrient arteries* to the radius and the ulna, and gives off the *median artery*—long and slender—which accompanies the median nerve.

The **carpal branches** of the ulnar artery are small arteries that arise near the wrist. They anastomose with corresponding branches of the radial artery in the formation of *anterior and posterior carpal arches.*

Ulnar Nerve.—The ulnar nerve arises in the axilla from the medial cord of the brachial plexus, descends through the medial part of the upper arm to the back of the medial epicondyle, and passes between the heads of the flexor carpi ulnaris to enter the forearm.

Course and Relations in Forearm.—It descends in the medial part of the front of the forearm, lying upon the flexor digitorum profundus, under cover of the flexor carpi ulnaris. Near the pisiform bone, it pierces the deep fascia at the lateral side of the flexor carpi ulnaris, and leaves the forearm by passing on to the front of the flexor retinaculum; and it ends on the retinaculum by dividing into two terminal branches —a superficial and a deep.

At the elbow, the ulnar nerve is separated from the ulnar artery by a wide interval; but, as they descend in the upper third of the forearm, the artery approaches the nerve, and, in the lower two-thirds, is closely applied to its lateral side.

Branches in Forearm.—The ulnar nerve gives off no branches till it reaches the forearm, where it supplies *articular*

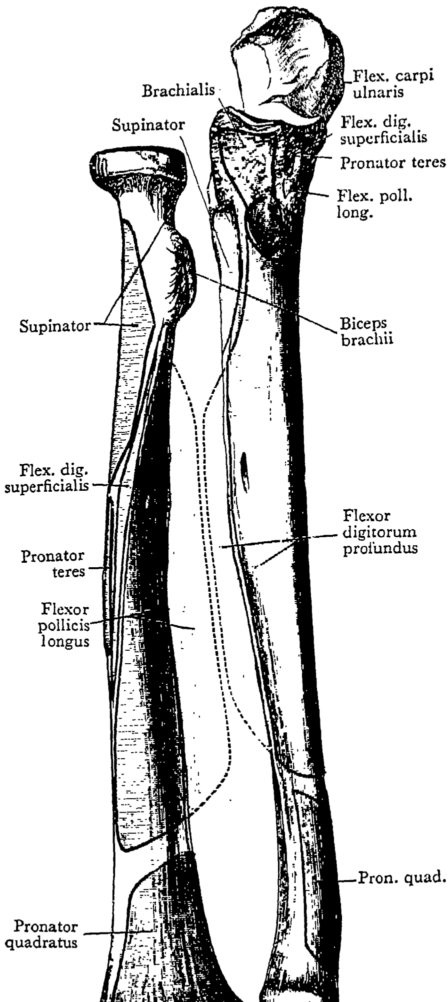


FIG. 61.—Front of Bones of Forearm with Muscular Attachments mapped out.

branches to the elbow joint; *muscular branches* which arise near the elbow for the flexor carpi ulnaris and the medial half of the flexor digitorum profundus; and the *dorsal* and *palmar cutaneous branches* (p. 79).

The ulnar nerve frequently receives a communication from the median nerve in the forearm; by this path, or through the slender contribution already noted (p. 99) from the lateral cord of the brachial plexus in the axilla, it obtains fibres derived from the seventh cervical nerve.

Median Nerve.—The median nerve arises in the axilla by two roots that spring from the lateral and medial cords of the brachial plexus. It descends through the upper arm,

at first on the medial side and then on the front, and passes in front of the elbow joint into the forearm (p. 99).

Course and Relations in Forearm.—In the cubital fossa, the median nerve lies in front of the brachialis at the medial side first of the brachial and then of the ulnar artery. It leaves the fossa by passing between the two heads of the pronator teres, and as it does so it crosses in front of the ulnar artery, but is separated from it by the ulnar head of the muscle. From that point the median nerve descends through the middle of the front of the forearm between the two flexors of the digits—adhering to the deep surface of the superficial flexor. Near the wrist, it winds round the lateral side of its tendons on to the front of them, and it then lies opposite the interval between the tendons of the palmaris longus and flexor carpi radialis (Fig. 53).

It leaves the forearm by entering the carpal tunnel behind the flexor retinaculum with the tendons of the flexor superficialis ; and it ends behind the retinaculum, near its distal border, by dividing into two terminal branches—a lateral and a medial.

Branches in Forearm.—Like the ulnar nerve, the median nerve gives off no branches in the upper arm. In the cubital fossa, it sends branches from its medial side to four muscles, namely, *pronator teres*, *flexor carpi radialis*, *palmaris* and *flexor digitorum superficialis*. As it leaves the fossa, it gives off the *anterior interosseous nerve*. In the distal half of the forearm, it may give another branch to the flexor superficialis, and, near the wrist, its *palmar cutaneous branch* springs from it (p. 79).

Dissection.—The *anterior interosseous nerve* has been traced down to the pronator quadratus. Now, divide the *pronator quadratus* by a vertical cut through its middle, and turn the two parts aside. Secure the branches that the anterior interosseous nerve gives to the muscle, and then trace the nerve down to the front of the wrist joint.

DEEP STRUCTURES OF FRONT OF FOREARM.—These are the anterior interosseous vessels and nerve, the flexor digitorum profundus, the flexor pollicis longus and the pronator quadratus.

The *anterior interosseous artery* has been studied (p. 131).

Anterior Interosseous Nerve.—This is a branch of the median nerve, and arises as the median nerve emerges from

between the two heads of the pronator teres. It descends over the front of the interosseous membrane—at first between the flexor profundus and the flexor longus pollicis, and then behind the pronator quadratus—and runs onwards to the front of the wrist joint. It gives *muscular* branches to those three muscles, and *articular* branches to the inferior radio-ulnar and wrist joints.

Flexor Digitorum Profundus.—The deep flexor of the fingers is a long, thick muscle that lies deeply in the front of the forearm; it lies also, more superficially, on the medial border and the back of the forearm, for it is on the medial side of the ulna as well as on the front of it. Examine the *back* of your forearm, and identify the posterior border of the ulna. The fleshy mass at the medial side of the groove that marks that border is the flexor profundus covered with the aponeurosis of the flexor carpi ulnaris. Place the fingers of your left hand on that mass on the back of the right forearm; close the right fist, and feel the muscle hardening as it contracts to flex the fingers.

The chief origin of the muscle is from the upper three-fourths of the medial and anterior surfaces of the ulna. The fleshy belly becomes a thick tendinous mass which divides into four tendons—one for each finger—but only the tendon for the forefinger becomes separate and distinct in the forearm. The tendons pass through the carpal tunnel into the palm; and each is inserted into the terminal phalanx of a finger.

The flexor digitorum profundus is supplied by the *anterior interosseous branch of the median* and by the *ulnar nerve*. It is a flexor of all the joints of the fingers, and of the wrist.

Flexor Pollicis Longus.—The long flexor of the thumb lies deeply in the forearm, taking origin chiefly from the upper two-thirds of the front of the radius. A rounded tendon issues from the fleshy belly, proceeds through the carpal tunnel into the palm, and runs to the thumb to be inserted into its terminal phalanx.

It is supplied by the *anterior interosseous nerve*. It is a flexor of all the joints of the thumb and a flexor of the wrist.

Pronator Quadratus.—The pronator quadratus lies deeply in the distal fourth of the forearm, taking origin from the front of the ulna, and passing across to be inserted into the radius. It is supplied by the *anterior interosseous nerve*; and its action is implied in its name.

Wrist and Palm

Before proceeding with the dissection of the palm, the student should revise its surface-anatomy (p. 69), the superficial nerves (pp. 79-81), and the deep fascia (p. 84).

The position and function of the palmaris brevis muscle should then be reviewed (p. 71).

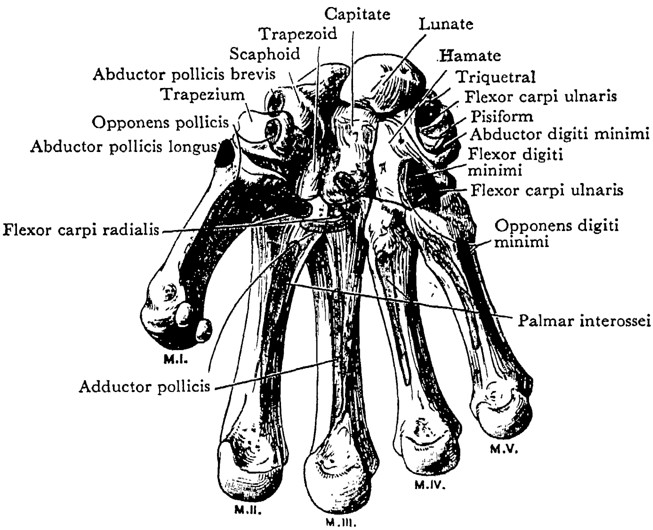


FIG. 62.—Palmar Surface of Bones of Carpus and Metacarpus with Muscular Attachments mapped out.

Palmaris Brevis.—This is a thin, subcutaneous muscle that lies across the proximal inch of the hypothenar eminence, concealing the termination of the ulnar artery and nerve. It arises from the flexor retinaculum and the palmar aponeurosis, and is inserted into the skin of the ulnar border of the hand. It is supplied by the superficial terminal branch of the ulnar nerve. Its action in deepening the " cup " of the palm has been already noted (p. 71); assisting the flexors of the digits, it enables the hand to take a firmer grip, for it raises up a cushion of skin and fascia on the hypothenar eminence, and prevents it from being flattened under pressure.

Dissection.—Reflect the palmaris brevis towards its origin, and secure its nerve of supply. Remove the deep fascia from the hypothenar muscles. Clean the *ulnar artery* till it disappears behind the palmar aponeurosis ; and secure its *deep palmar branch*, which sinks backwards between the hypothenar muscles. Trace the terminal branches of the *ulnar nerve*—the superficial to its subdivision into the palmar digital branches (dissected already); and the deep branch into the cleft between the two superficial muscles of the hypothenar eminence, securing its branches to those two muscles and to the deeper muscle of the eminence. Then, separate and clean those three muscles, avoiding injury to the nerves.

Short Muscles of Little Finger.—The three short muscles of the little finger make up the hypothenar eminence or ball of the little finger. They are the abductor, the flexor, and the opponens. The abductor lies along the medial side of the flexor, and the opponens is deep to both. They are all supplied by the deep branch of the *ulnar nerve.*

These muscles have a more or less common origin from the pisiform bone (abductor), the hook of the hamate and the medial part of the flexor retinaculum (flexor and opponens). The *abductor* is inserted into the medial side of the base of the proximal phalanx of the little finger. The *flexor* is variable in size, and is inserted with the abductor. It is partly fused with the abductor, and may not be easily separated from the opponens. The *opponens* lies on a deeper plane, and is inserted into the whole length of the medial part of the front of the fifth metacarpal bone.

These muscles should be compared with the corresponding short muscles of the thumb (p. 148).

Dissection.—Separate the apex of the palmar aponeurosis from the tendon of the palmaris longus and from the flexor retinaculum, and define the distal margin of the retinaculum. Then, reflect the aponeurosis towards the roots of the fingers. Do not fail to note that, from its medial and lateral margins, septa pass backwards into the palm. Divide these septa, and continue the reflexion until the deep surfaces of the processes which pass to the fingers are fully exposed. Note that, at the roots of the fingers, each process divides into two slips. Clean these two slips, and note their connexions with the fibrous flexor sheath and with more deeply placed ligaments.

Palmar Aponeurosis.—This dense, strong fibrous sheet underlies the superficial fascia of the middle part of the palm, and protects the tendons and the chief vessels and nerves which are proceeding to the fingers. It is composed of strong

longitudinal fibres mixed with transverse fibres which bind them together.

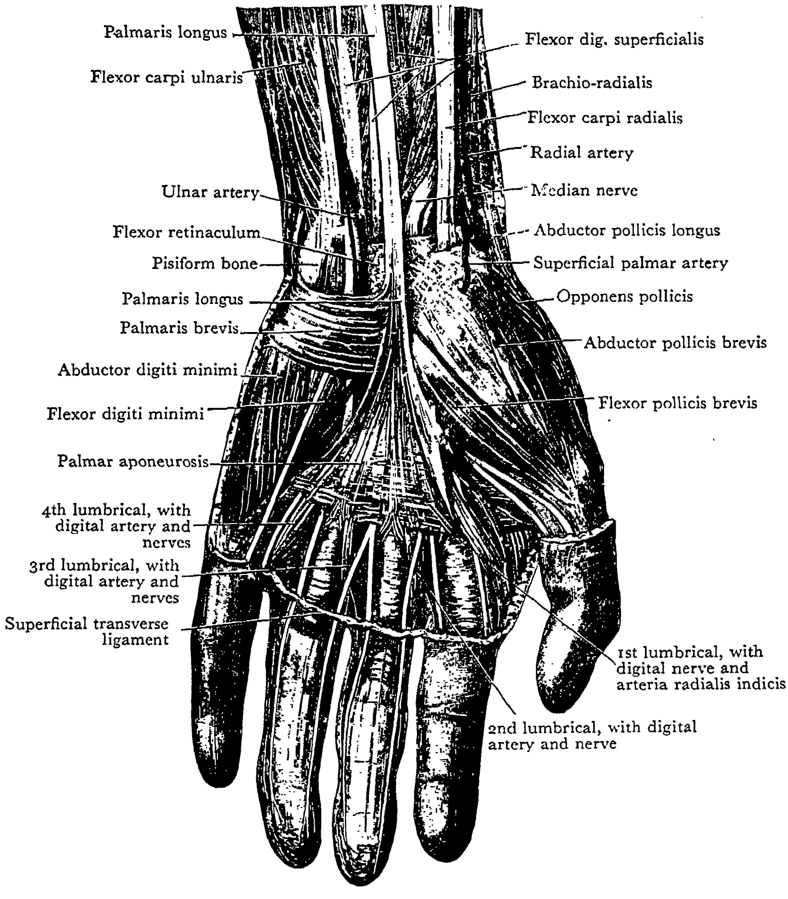


FIG. 63.—Superficial Dissection of Palm. The deep fascia has been removed from the thenar and hypothenar eminences.

It is triangular in outline. Its *apex* is situated at the distal border of the flexor retinaculum. There, its deeper fibres fuse with the retinaculum, while the superficial fibres are continuous with the tendon of the palmaris longus.

Its *lateral* and *medial margins* are continuous with the deep fascia that covers the thenar and hypothenar muscles; and, from each margin, a septum is sent backwards into the palm to fuse with the fascia on the muscles that lie deeply in the palm. These two septa separate the thenar and hypothenar muscles from the long flexor tendons of the fingers.

The *base* of the aponeurosis is opposite the distal parts of the metacarpal bones. It divides into four processes—one for each finger. Each process passes towards the root of a digit and divides into two slips. The slips diverge from each other and curve backwards. Their distal borders are continuous with the fibrous flexor sheath of the digit; their ends fuse with the deep fascia on the back of the digit and with strong bands called the deep transverse ligaments of the palm.

A progressive shortening of the medial part of the palmar aponeurosis is known as *Dupuytren's Contraction*; it produces flexion of the ring and little fingers, and is a chronic condition that requires surgical treatment.

Fascial Planes and Compartments of Palm (Fig. 56).—The two septa which pass from the margins of the palmar aponeurosis into the depths of the palm join the fascia on deeper muscles—the medial interosseous muscles and the adductor of the thumb; and the two heads of the adductor are separated from the interossei of the lateral two interosseous spaces by another layer of fascia. There are, therefore, four main fascial compartments in the palm:—

1. A lateral compartment which contains the thenar muscles.
2. A medial compartment which contains the hypothenar muscles.
3. An intermediate compartment, separated into (*a*) a superficial part which contains the superficial palmar arch and its branches and branches of the median and ulnar nerves, and (*b*) a deeper part with the flexor tendons and their sheaths.
4. An adductor compartment which contains the adductor pollicis.

When wounds of the fingers or hand become infected, there may be effusion of serum or the formation of pus in the fascial plane deep to the flexor tendons (Fig. 56). That plane then becomes loosened to form the "fascial spaces" recognised by the surgeon (p. 150).

Dissection.—Clean the *superficial palmar arch* and the four *digital branches* which it gives to the fingers.

Find the terminal branches of the *median nerve* at the lower

border of the flexor retinaculum. Follow the lateral branch first. Secure the stout branch that it gives to the thenar muscles, and follow it to the point where it disappears behind the lateral muscle. Then, trace the digital nerves to the thumb and forefinger, and secure the branch of the latter to a slender slip of muscle called the *first lumbrical muscle.* Now, follow the two digital nerves into which the medial branch divides; do so with care, for the lateral one gives a branch to the *second lumbrical muscle,* and the other communicates with the nearest digital branch of the ulnar nerve.

Superficial Palmar Arch.—The term superficial palmar arch is applied to an arterial arcade which lies immediately subjacent to the palmar aponeurosis, its most distal point being situated at the level of the distal border of the fully abducted thumb. It is the continuation of the ulnar artery after that artery has given off its deep branch. It begins therefore on the flexor retinaculum immediately below the level of the pisiform bone. It first descends across the medial side of the apex of the hook of the os hamatum, behind the palmaris brevis; but, a short distance distal to the hook, it turns laterally, pierces the medial septum of the palm, crosses behind the palmar aponeurosis (Fig. 56), and unites with one or other of the branches of the radial artery (Figs. 64, 68). The arch lies on the digital branches of the median nerve and the flexor tendons.

Branches.—The arch gives off small twigs to the adjacent tendons and fascia, but its chief branches are the *four digital arteries* which spring from its convexity. The first of the four remains undivided. It runs to the medial border of the little finger, along which it passes to the terminal phalanx. The other three branches—second, third, fourth—pass towards the three interdigital clefts, and each divides, at the level of the bases of the first phalanges, into two branches, which supply the sides of the adjacent fingers (Figs. 57, 64, 68).

Opposite the terminal phalanx, the two arteries of each finger join to form an arch from which a great number of fine branches are distributed to the pulp of the finger and to the bed upon which the nail rests.

At the interdigital clefts the digital arteries are joined by the corresponding *palmar metacarpal arteries* from the deep palmar arch.

Median Nerve.—This nerve was traced as far as the flexor retinaculum when the front of the forearm was dissected. As it descends into the palm of the hand, it lies behind the flexor retinaculum, in front of the tendons of the flexor digitorum superficialis, or along their lateral margin (Fig. 59),

and in close relation with their synovial sheath. Near the distal border of the retinaculum, it splits into a lateral and a medial division.

The *lateral division* is the smaller. It gives off a branch

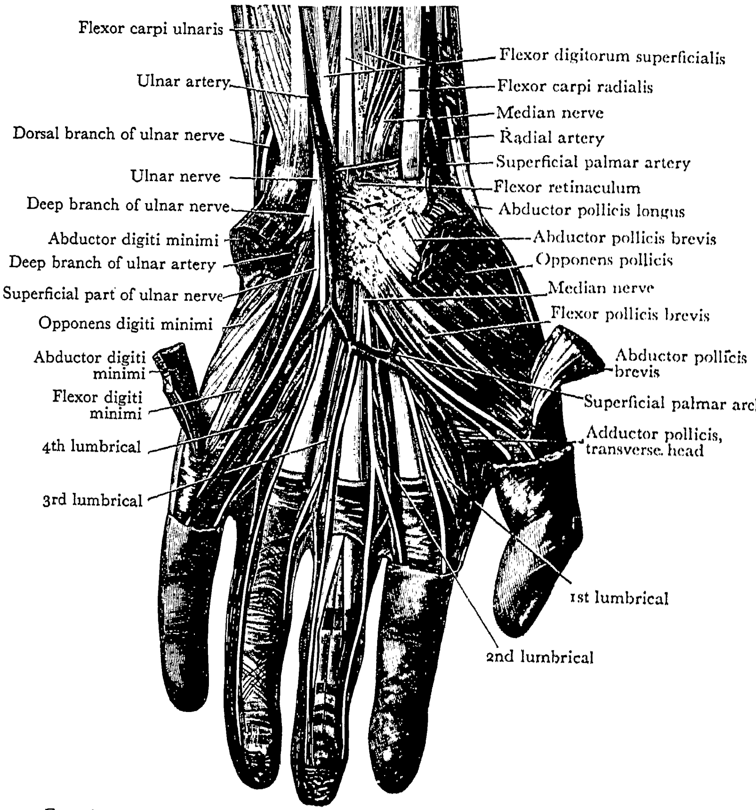


FIG. 64.—Parts in Palm displayed by Removal of Palmar Aponeurosis. In this specimen the radialis indicis and the princeps pollicis arteries took origin from the superficial palmar arch.

which supplies the abductor brevis, the opponens and the flexor brevis of the thumb. It then divides into three digital branches; two of them go to the sides of the thumb; the third runs to the radial side of the index finger and, on its way, it gives a twig to the first lumbrical muscle.

The *medial division* divides into two branches. One runs

towards the cleft between the index and middle fingers and divides to supply the adjacent sides of those fingers; before it divides, it gives a branch to the second lumbrical muscle. The other gives a communicating twig to the lateral digital branch of the ulnar nerve, and divides to supply the adjacent sides of the middle and ring digits. It sometimes gives a branch to the third lumbrical muscle.

In the palm, the digital branches of the median nerve are behind the superficial palmar arch and its digital branches; but, as they approach the fingers, they cross the digital arteries to lie in front of them on the fingers. Note also that the digital nerves divide at a higher level than the arteries do. Their distribution in the digits is described on p. 81.

Ulnar Nerve.—The ulnar nerve enters the hand by passing on to the front of the flexor retinaculum close to the lateral side of the pisiform bone; it divides there into two terminal branches—a superficial and a deep.

The *deep branch* passes to the medial side of the hook of the os hamatum, and then dips deeply into the palm, with the deep branch of the ulnar artery, through the cleft between the abductor and the flexor of the little finger. It supplies the short muscles of the little finger as it passes between them, and afterwards gives branches to numerous other muscles. Its further course and distribution will be seen when the deep part of the palm is dissected (p. 148).

The *superficial branch* descends under cover of the palmaris brevis, to which it gives a twig of supply, and divides into two digital branches. The medial of the two branches passes to the medial side of the little finger. The lateral branch is joined by a communicating branch from the nearest digital branch of the median nerve, and then divides into two branches which supply the adjacent sides of the ring and little fingers (p. 81).

Dissection.—Remove the deep fascia from the muscles of the thenar eminence, but preserve their nerve of supply. Two muscles are then exposed—the abductor and flexor pollicis brevis. The *abductor* is the lateral muscle; pass the handle of the scalpel behind its lateral border and lift it from the opponens pollicis. Then, divide the abductor, and turn the two parts upwards and downwards. The *opponens* is then exposed, and must be cleaned.

Next, divide the *short flexor* at its middle and reflect it towards its ends. That will bring into view part of the *adductor pollicis*, emerging from behind the flexor tendons; and, along the medial

border of the opponens pollicis, the tendon of the flexor pollicis longus will be seen ; do not injure its synovial sheath.

At this stage, re-examine the synovial sheaths of the flexor tendons by inflation or with a blunt probe (see p. 123).

Flexor Retinaculum.—Examine this band thoroughly before you divide it to expose the portions of the flexor tendons that lie behind it.

It is a thick, dense, fibrous band which stretches across the concavity of the carpus and converts it into an osteo-fibrous

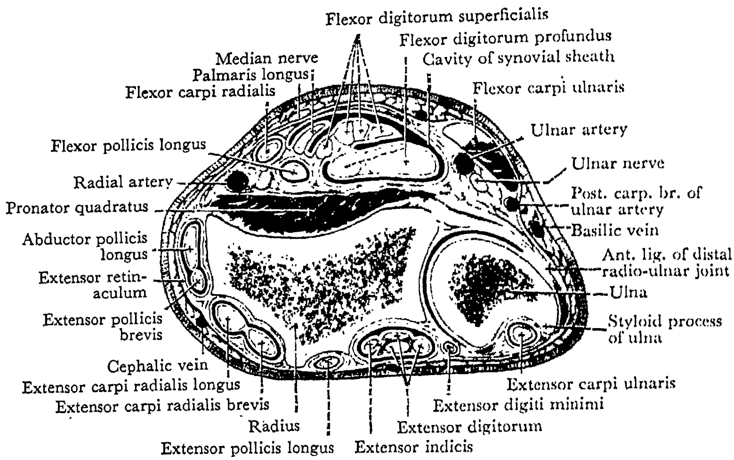


FIG. 65.—Transverse Section through Forearm above Flexor Retinaculum. Showing the relation of the Synovial Sheaths to the Tendons.

tunnel for the passage of the flexor tendons into the palm. At the sides, it is attached to the piers of the carpal arch, viz.—on the *lateral side* to the tubercle of the scaphoid bone and the front of the trapezium; on the *medial side* to the pisiform and the hook of the hamate. The attachment to the trapezium is chiefly to the crest at the lateral side of the groove on the front of the bone; but it sends a process also to the medial margin of the groove. In that way, it converts the groove into a canal which transmits the flexor carpi radialis tendon and is lined with its synovial sheath.

The proximal margin of the retinaculum is continuous with the deep fascia of the forearm, and its distal border is connected with the palmar aponeurosis.

The retinaculum is partly concealed by the *thenar* and

hypothenar muscles that arise from it, and by five structures that descend on to its surface:—(1) the *ulnar nerve*, close to the pisiform bone; (2) the *ulnar vessels*, on the lateral side of the nerve; (3) the *palmar cutaneous branch of the ulnar nerve*, lateral to the vessels; (4) *palmaris longus tendon*, at the middle of the retinaculum; and (5) the *palmar cutaneous branch of the median nerve*, at the lateral side of the tendon.

The tunnel which the flexor retinaculum forms with the

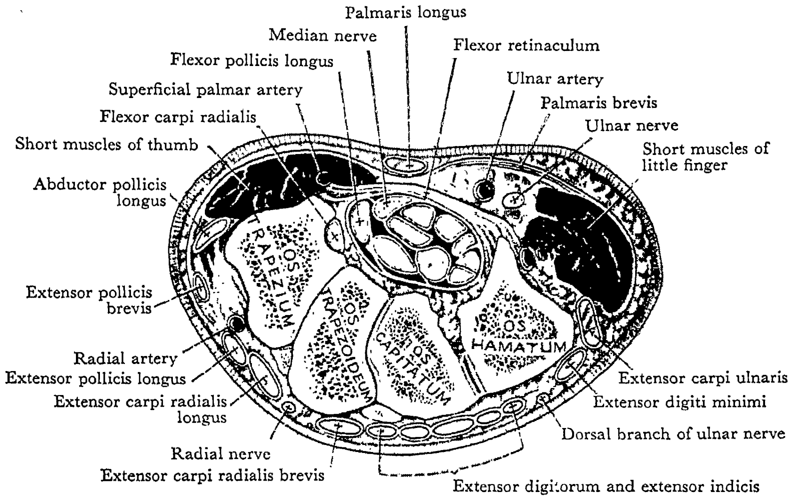


FIG. 66.—Transverse Section at the level of Distal Row of Carpal Bones. Besides the Flexor Pollicis Longus and the Median Nerve, which are labelled, the tendons of the two Flexors (superficial and deep) of the Digits are seen in the Carpal Tunnel. Note that the sheath of Flexor Pollicis Longus is continuous with the common sheath at this level.

concavity of the carpus transmits the tendons of the superficial and deep flexors of the digits, flexor pollicis longus and the median nerve.

***Dissection.*—Clean the fibrous sheaths of the flexor tendons of the fingers and the thumb.**

Fibrous Flexor Sheaths.—The fibrous flexor sheaths are simply the deep fascia of the fronts of the digits greatly condensed in order to hold the flexor tendons in contact with the palmar surfaces of the phalanges and the joints during flexion of the digits. Each sheath is an elongated plate

curved round the front and sides of the flexor tendons. Its edges are attached to the margins of the phalanges and the margins of the palmar ligaments of the metacarpo-phalangeal and interphalangeal joints. Its distal end is attached to the palmar surface of the distal phalanx immediately beyond the insertion of the flexor profundus tendon. At its proximal end, it is continuous with the corresponding slip or process of the palmar aponeurosis. It consists chiefly of transverse fibres; and it is very dense opposite the phalanges, but is thinner and weaker opposite the joints in order that it may not interfere with flexion.

Each sheath, together with the phalanges and the palmar ligaments of the joints, forms an osteo-fibrous canal which lodges the flexor tendons enclosed in a synovial sheath. In a finger, the tendons are the flexor sublimis and profundus; in the thumb, it is flexor pollicis longus alone.

Dissection.—Leave the fibrous sheath of the middle finger intact for revision. Open the other sheaths by longitudinal incisions. Evert the two halves of the fibrous sheath, and examine the extent and arrangement of the synovial sheath. Lift up the tendons and separate them. Examine their insertions; note their relations to each other; and examine also the slender bands, called *vincula*, which connect the tendons to the phalanges.

Synovial Sheaths in the Digits.—Each synovial sheath extends to the insertion of the tendon into the base of the terminal phalanx. The sheath of the thumb extends from the interphalangeal joint up into the forearm an inch above the crease at the wrist. The sheath of the little finger is continuous with the common flexor sheath in the palm. The sheaths of the other digits extend almost to the middle of the palm, but are not continuous with the large sheath (Fig. 58, p. 125).

Each sheath has two layers. One layer lines the canal; the other covers the tendons, investing each tendon separately. They are continuous with each other at the ends of the sheath; their contiguous surfaces are smooth and glistening, and are moistened with the film of synovia that fills the capillary interval between them.

Vincula Tendinum.—These are thin fibrous structures that pass between the bones and the tendons. They carry blood-vessels to the tendons; and they are covered with synovial membrane. They are of two kinds—long and short. The *vincula brevia* are triangular sheets set between the bones and

the tendons at their insertion. The *vincula longa* are very slender bands situated nearer the root of the finger (Fig. 67).

Dissection.—Open the carpal tunnel by making a vertical incision through the middle of the flexor retinaculum. Clean the synovial sheaths from the flexor tendons. Separate the tendons carefully from one another, and clean the slender slips —the *lumbrical muscles*—which spring from the tendons of the flexor digitorum profundus, taking care not to injure their nerves.

Examine the arrangement of the flexor tendons and the origins and insertions of the lumbrical muscles.

Tendon of Flexor Pollicis Longus.—This tendon occupies the lateral part of the carpal tunnel, turns laterally in the palm and runs towards the thumb along the

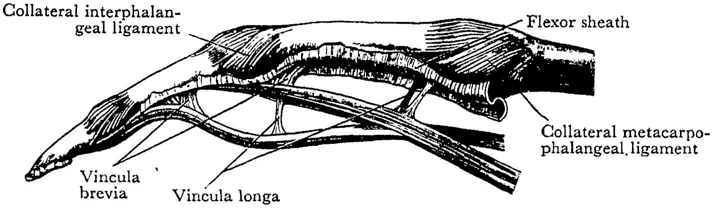


FIG. 67.—Flexor Tendons of a Finger with Vincula Tendinum.

lower margin of the thenar eminence between the flexor pollicis brevis and adductor pollicis. It enters the fibrous flexor sheath at the base of the proximal phalanx, and then runs to the base of the terminal phalanx, into which it is inserted.

Flexor Tendons of Fingers.—Deep to the flexor retinaculum, the four tendons of the *flexor superficialis* are arranged in pairs ; those for the little finger and the index lie behind those for the ring and middle fingers. Of the tendons of the *flexor profundus*, only that for the index finger is distinct and separate ; the other three, as a rule, remain united until the tendinous mass emerges from under cover of the retinaculum.

In the palm, the flexor tendons diverge from each other ; and two—one from each flexor—go to each of the four fingers. The lumbrical muscles and the palmar digital nerves and arteries will be seen in the intervals between the tendons as they approach the fingers.

In the *fingers*, the two flexor tendons run along the palmar

surfaces of the phalanges, and are held in position by the fibrous flexor sheaths. On the palmar surface of the first phalanx, the tendon of the flexor sublimis becomes flattened and folded round the subjacent tendon of the flexor profundus.

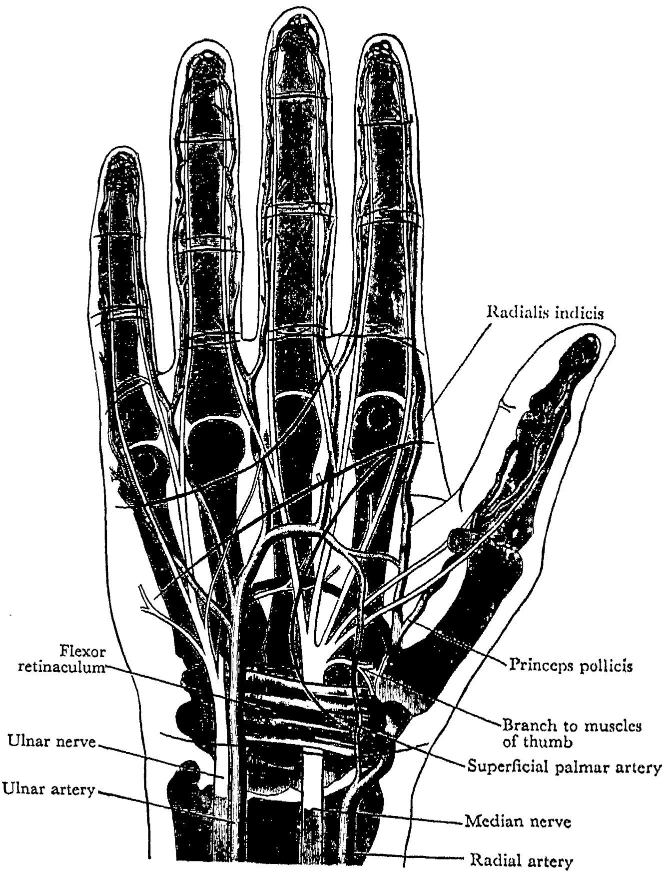


FIG. 68.—Diagram of Nerves and Vessels of Hand in relation to Bones and Skin-Markings. (Cf. Pl. XII, Fig. 57.)

It then splits into two parts which pass behind the tendon of the flexor profundus, where their *reversed edges* fuse together and partially decussate; they then diverge again to be inserted into the borders of the shaft of the second phalanx.

By this special arrangement the tendon of the flexor sublimis forms a short tubular passage, which cannot be obliterated by tension, through which the tendon of the flexor profundus proceeds onwards to the base of the terminal phalanx. In each of the four fingers the same arrangement is found: the tendon of the flexor sublimis is inserted by two slips into the margins of the palmar surface of the second phalanx, and the tendon of the flexor profundus passes through it to be inserted into the palmar surface of the base of the terminal phalanx.

Lumbrical Muscles.—The lumbrical muscles are four slender fleshy bellies which arise from the radial or adjacent sides of the tendons of the flexor digitorum profundus as they traverse the palm. Each of them ends in a delicate tendon which passes backwards across the radial surface of a metacarpo-phalangeal joint, is connected with the expansion of the extensor tendon, and is inserted, with the tendon of an interosseous muscle, into the base of a terminal phalanx (p. 159 and Fig. 78). Their action is explained on p. 160.

The lateral two lumbrical muscles are supplied on their superficial surface by twigs from the digital branches of the median nerve for the index finger; the medial two on their deep surface by the deep branch of the ulnar nerve; the third lumbrical often receives an additional twig from the most medial digital branch of the median nerve.

Dissection.—Divide the flexor digitorum profundus in the forearm, and turn the distal part towards the fingers. As the tendons and the lumbrical muscles are raised, secure the fine twigs of supply which pass to the medial two lumbricals.

Now, clean the *deep palmar arch* and the *deep branch of the ulnar nerve*, and trace the branches of the nerve to the interosseous muscles and to the adductor pollicis.

Deep Palmar Arch.—Two arteries take part in the arch—the radial and the deep palmar branch of the ulnar.

The radial plays the chief part. It enters the palm through the proximal end of the first interosseous space, between the two heads of the first dorsal interosseous muscle. In the present stage of dissection, it is seen appearing through the cleft between the oblique and transverse heads of the adductor pollicis (or through the transverse head), and running medially to join the deep branch of the ulnar artery at the base of the fifth metacarpal bone.

The arterial arcade, so formed, lies across the metacarpal bones immediately distal to their bases. The deep arch is therefore about a finger's breadth nearer the wrist than the superficial arch. The convexity of the deep arch is directed towards the fingers; and the deep branch of the ulnar nerve lies in its concavity (Figs. 57, 68).

Its chief branches are three *palmar metacarpal arteries*, which run towards the interdigital clefts and unite with digital branches of the superficial arch. Sometimes these metacarpal arteries are large and take the place of the corresponding palmar digital arteries.

Deep Branch of Ulnar Nerve.—This branch springs from the parent trunk on the front of the flexor retinaculum, and at once gives off a branch that divides to supply the three short muscles of the little finger. Accompanied by the deep branch of the ulnar artery, it then sinks into the interval between the abductor and flexor digiti minimi, and turns laterally across the palm, deep to the flexor tendons. Near the lateral border of the palm, it breaks up into terminal twigs which supply the adductor pollicis and the first dorsal interosseous muscle. In its course across the palm, it lies along the proximal border of the deep palmar arch, and sends three fine branches downwards in front of the three interosseous spaces. They supply the interosseous muscles in these spaces; and the medial two give branches also to the medial two lumbrical muscles.

The deep branch of the ulnar nerve therefore supplies all the muscles of the palm which are medial to the tendon of the flexor pollicis longus, except the lateral two lumbrical muscles, which are supplied by the median nerve. It is of some clinical importance, however, to note that the flexor pollicis brevis often receives a branch from the ulnar nerve in addition to its branch from the median nerve, or even as the sole supply of the muscle.

Dissection.—Clean the adductor of the thumb and then examine the other short muscles of the thumb.

Short Muscles of Thumb.—Three of the short muscles of the thumb have already been dissected. All four are now displayed; and their positions and attachments should be studied. Three of the four—the abductor and flexor brevis and the opponens—are lateral to the tendon of the

flexor pollicis longus and form the ball of the thumb; they are supplied by the median nerve. The fourth muscle—the adductor—is medial to that tendon and is supplied by the deep branch of the ulnar nerve, which, as noted above, may supply the flexor brevis also.

The *abductor pollicis brevis* forms the upper or lateral part of the ball of the thumb. The *flexor pollicis brevis* is immediately below or medial to the abductor. The *opponens pollicis* is deep to both of them and is exposed when they are pulled apart or are reflected (Figs. 63, 64). All three arise from the lateral part of the flexor retinaculum with some of the more lateral and deeper fibres gaining origin from the tubercles of the scaphoid and the trapezium (Fig. 62).

The abductor and the flexor are inserted together into the lateral side of the base of the proximal phalanx of the thumb. The fibres of the opponens spread out to be inserted into the lateral half of the palmar surface of the first metacarpal bone.

Adductor Pollicis.—The adductor of the thumb is a fan-shaped muscle that lies deeply in the palm; it is imperfectly divided into an upper and a lower part, called respectively its oblique and transverse heads. The *oblique head* arises mainly from the bases of the second and third metacarpals and the adjacent carpal bones. The *transverse head* arises from the front of the third metacarpal bone (Fig. 62). The two heads converge, unite, and are inserted into the medial side of the base of the proximal phalanx of the thumb.

These muscles should be compared with the corresponding short muscles of the little finger (see p. 136).

Sesamoid Bones.—A small sesamoid bone is developed in the tendon of the adductor pollicis and another in the common tendon of the abductor and flexor (Fig. 75). One surface of each of these little bones is covered with cartilage and plays upon the palmar surface of the head of the first metacarpal bone, which is grooved to articulate with them.

Dissection.—To display the branches of the palmar part of the radial artery, cut through the two parts of the adductor pollicis midway between their origins and insertions, and turn the separated portions aside. The *first dorsal interosseous muscle* is now exposed; the radial artery will be found entering the palm between its two heads, and giving off its last two branches—the *princeps pollicis* and the *radialis indicis.* At the same time, look for a slender slip of muscle—the *first palmar interosseous* (p. 169)—that lies along the ulnar side of the first metacarpal bone.

Radial Artery in Palm.—The radial artery enters the palm through the proximal end of the first intermetacarpal space between the two heads of the first dorsal interosseous muscle. In the palm, it lies at first between that muscle and the adductor pollicis, where it gives off the *radialis indicis* and *princeps pollicis* arteries; and then it passes through the adductor to become the deep palmar arch (Fig. 57).

The **radialis indicis artery** descends between the transverse head of the adductor pollicis and the first dorsal interosseous muscle to the lateral border of the index, along which it proceeds as its lateral palmar digital artery.

The **princeps pollicis artery** runs laterally, under cover of the oblique head of the adductor, to the metacarpal bone of the thumb, where it lies behind the long flexor tendon, and divides into two branches. Those two branches run onwards along the sides of the long flexor as the palmar digital arteries of the thumb.

Surgical Anatomy of the Fingers and Palm.—The fingers are subject to an inflammatory process termed *whitlow*, and, in connection with this, remember that the flexor fibrous sheath ends on the base of the distal phalanx in each digit. When the whitlow occurs lower down—in the pulp of the finger—the vitality of the distal part of the terminal phalanx is endangered, but the flexor tendons may be regarded as being fairly safe. When the inflammation occurs at a higher level and involves the flexor sheath, as it generally does, sloughing of the tendons is to be apprehended unless an immediate opening is made. No slight superficial incision will suffice. The knife must be carried deeply through the side of the finger, so as to lay open freely the sheath containing the tendons. Early interference in whitlow of the thumb and little finger is even more urgently required than in the case of the other three digits, because the digital synovial sheath of the little finger is almost invariably continuous with the common sheath of the flexor tendons (Fig. 58) and that of the thumb usually connected with it (Fig. 66), so that they offer a ready means for the extension of the inflammatory action upwards.

When an abscess (*i.e.*, a collection of pus) forms in the superficial intermediate compartment of the palm, early surgical interference is urgently called for. The dense palmar aponeurosis effectually prevents the passage of the pus to the surface of the palm, and it tends to spread deeply into the synovial sheath of the flexor tendons. It is necessary, therefore, that before this can occur the surgeon should make openings by means of which the pus can escape; such openings must take account of the position of the superficial palmar arch and of the palmar digital arteries that spring from it.

The synovial sheath which envelops the flexor tendons has been seen to extend upwards into the distal part of the forearm, and downwards into the palm. When the sheath is attacked by inflammation, it is liable to become distended with fluid which may become purulent, and the anatomical arrangement of the parts at once offers an explanation of the appearance which is presented. There is a bulging in the proximal

PLATE XIII

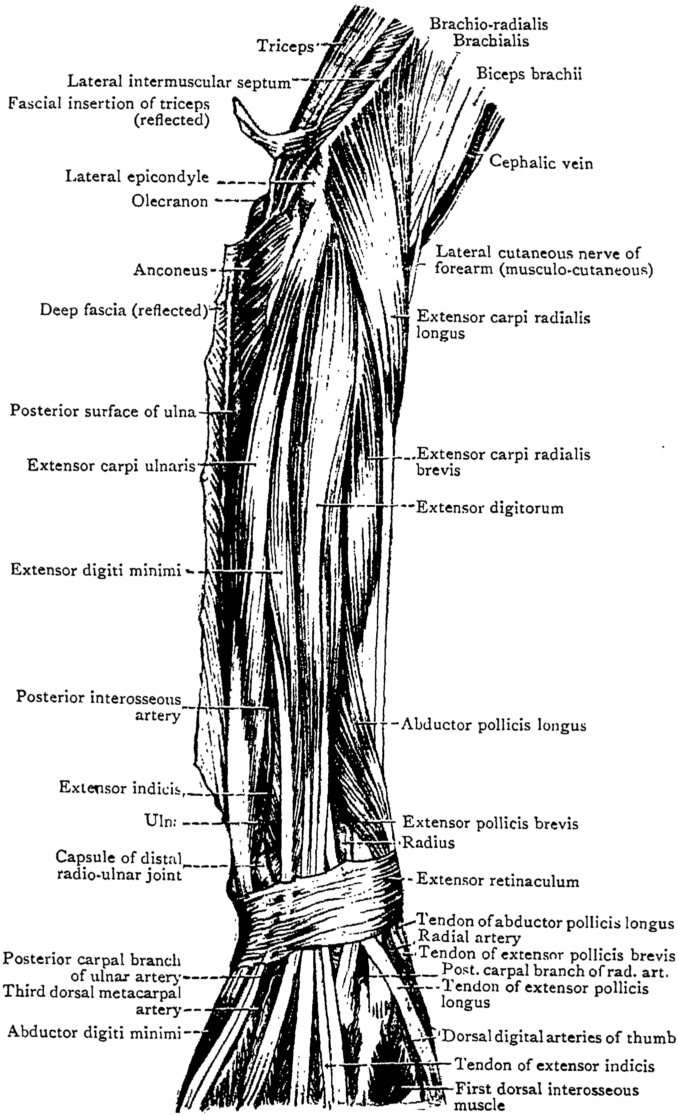


FIG. 69.—Superficial Dissection of Back of Forearm.

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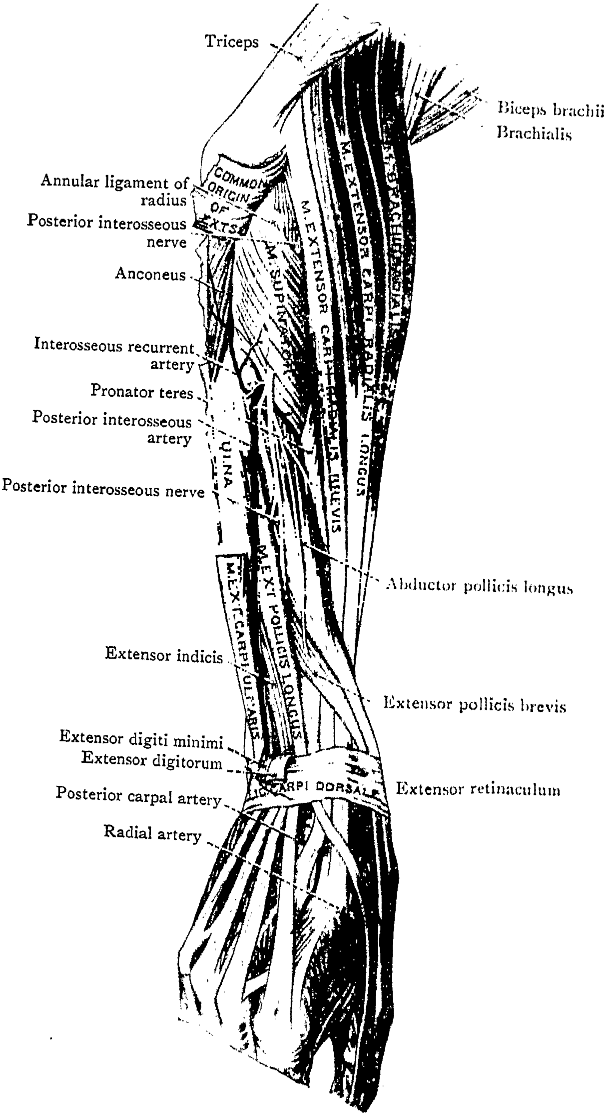

FIG. 70.—Deep Dissection of Back of Forearm.

[Facing p. 151

part of the palm, and a bulging in the distal part of the forearm, but no swelling at all opposite the carpus. There, the flexor retinaculum resists the expansion of the synovial sheath.

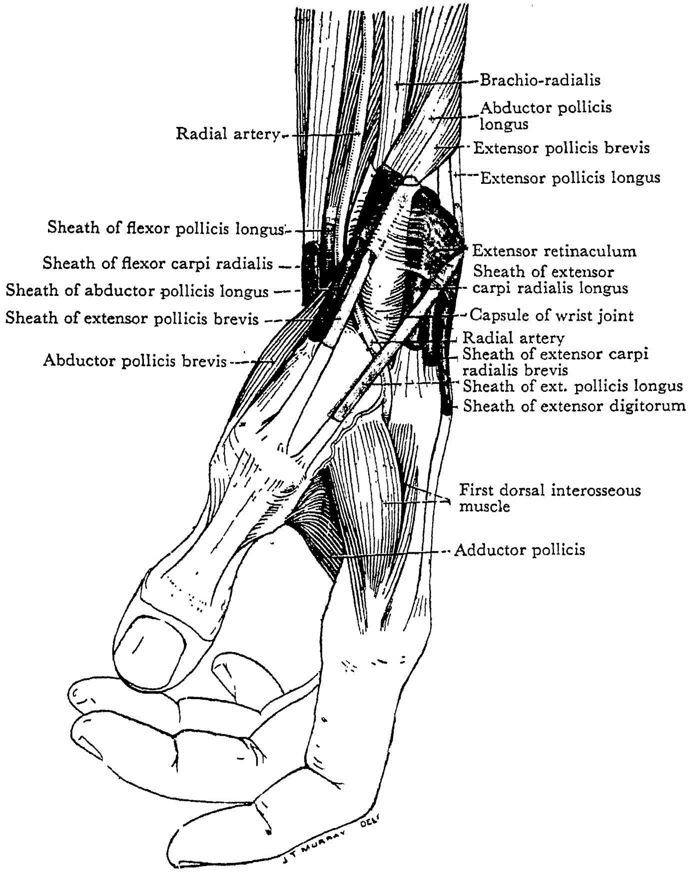

FIG. 71.—Dissection of Lateral Side of Left Wrist and Hand. Showing Synovial Sheaths of Tendons.

The commonest site for an abscess in the palm is deep to the flexor synovial sheath, for pus may gather, on either side of the middle metacarpal bone, in the fascial plane between the common flexor synovial sheath and (*a*) the adductor pollicis and (*b*) the medial two sets of interosseous muscles (Fig. 56). Such accumulations open up the fascial plane to form " fascial spaces " separated by a more resistant fascial septum attached to the middle metacarpal bone. These two spaces may be appropriately named the *lateral* and *medial mid-palmar spaces*

(respectively, the " thenar " and " mid-palmar " spaces of the surgeons).
Details of routes of infection in the palm, and of the sites of incisions required to deal with them, are given in special works on Surgical Anatomy.

BACK AND LATERAL BORDER OF FOREARM AND BACK OF HAND

Before this dissection is begun, revise the surface anatomy (pp. 67-70), and re-examine the superficial veins, the cutaneous nerves and the deep fascia (pp. 72, 78, 80, 83).

Dissection.—Leave the extensor retinaculum (p. 83) *in situ* until the dissection of the back of the forearm and hand is completed. To secure its retention, isolate it by cutting carefully through the deep fascia parallel with its upper border—avoiding injury to the synovial sheaths of the extensor tendons, which lie immediately subjacent to the deep fascia.

When the front of the forearm was dissected, the lateral flap of deep fascia was reflected only as far as the radial border of the forearm. Now, continue the reflexion until the attachment of the flap to the posterior border of the ulna is reached. As the reflexion proceeds, divide the intermuscular septa.

Muscles of Back of Forearm.—The muscles in this region are more numerous than on the front, and, like them, are arranged in a superficial and a deep group.

Named from the lateral to the medial border of the forearm, the *superficial muscles* are :—

1. Brachio-radialis.
2. Extensor carpi radialis longus.
3. Extensor carpi radialis brevis.
4. Extensor digitorum.
5. Extensor digiti minimi.
6. Extensor carpi ulnaris.
7. Anconeus.

This group therefore comprises one flexor of the elbow (the brachio-radialis, see p. 121), three extensors of the wrist, two extensors of the fingers, and a feeble extensor of the elbow (the anconeus). Identify them at once from their relative positions and by reference to Fig. 69. They are all long muscles except the anconeus, which is the small, triangular muscle on the lateral side of the upper part of the ulna.

The *deep muscles*, named from above downwards, are :—

1. Supinator.
2. Abductor pollicis longus.
3. Extensor pollicis brevis.
4. Extensor pollicis longus.
5. Extensor indicis.

They also are long muscles, except the supinator, which is wrapped round the upper third of the radius.

Though deep in the greater part of their extent, three of these muscles appear in the distal part of the forearm between the extensor digitorum and the extensor carpi radialis brevis. Identify, by reference to Figs. 69 and 70, the long abductor and the two extensors of the thumb as they come to the surface. The tendon of the fourth long muscle of the deep group—the *extensor indicis*—will be found under cover of the extensor digitorum near the wrist.

Before the muscles are cleaned and studied, the dissectors will examine the extensor retinaculum and the synovial sheaths that surround the tendons. The deep fascia of the dorsum of the hand is so thin that it will not prevent a successful demonstration of the synovial sheaths.

Dissection.—Introduce a blowpipe into each sheath immediately above the retinaculum, and inflate the sheath. A better demonstration may be made by a thin mixture of coloured starch injected through a large hypodermic syringe. If the sheaths have been injured, and it is not possible to distend them, then open each and examine its extent with the aid of a blunt probe.

Extensor Retinaculum.—This fascial band, about an inch wide, lies obliquely across the back of the limb at the junction of the forearm and the wrist. Its superficial surface is crossed, at its medial end, by the basilic vein, and, towards its lateral end, by the cephalic vein and the terminal branches of the radial nerve.

It is longer than the flexor retinaculum; but it is not so strong, for extension at the wrist is not so powerful as flexion, and the extensors are less liable than the flexors to spring away from the wrist. It is merely a thickened portion of the deep fascia, and its attachments are so arranged that it does not interfere with the free movement of the radius and hand during pronation and supination.

Its *medial end* is attached to the triquetral bone and the styloid process of the ulna. The lateral part must include the tendons that cross the lateral surface of the distal end of the radius; the *lateral end* therefore reaches the front of the limb and is attached to the sharp edge between the lateral and anterior surfaces of the distal end of the radius (Fig. 71).

Under the flexor retinaculum, one large compartment or tunnel is formed for the flexor tendons. Not so under the extensor retinaculum: five septa spring from its deep surface to be attached to the head of the ulna and to the

ridges on the back of the lower end of the radius, giving additional attachments to the retinaculum and dividing the space under cover of it into six compartments. Each compartment transmits either one or two tendons, and is lined with a synovial sheath which envelops the tendon or tendons and facilitates their play between the retinaculum and the bone (Fig. 76).

Dissection.—**Slit the ligament at each compartment. Examine the tendons and synovial sheaths that lie in them.**

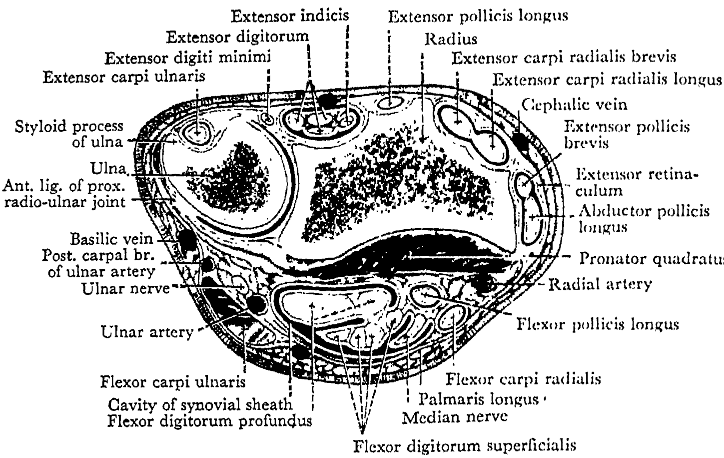

FIG. 72.—Transverse Section through Forearm above Flexor Retinaculum. Showing the relation of the Synovial Sheaths to the Tendons.

The *first compartment* is on the lateral side of the distal end of the radius. It contains the tendons of the abductor pollicis longus and the extensor pollicis brevis.

The *second compartment* corresponds with the most lateral groove on the back of the radius. It holds the tendons of the two radial extensors of the carpus.

The *third compartment* is formed over the narrow, deep, oblique groove on the distal end of the radius. It contains the tendon of the extensor pollicis longus.

The *fourth compartment* is placed over the wide, shallow groove which marks the medial part of the back of the distal end of the radius. It is traversed by tendons of the extensor digitorum and extensor indicis and, deep to their sheath, by

PLATE XV

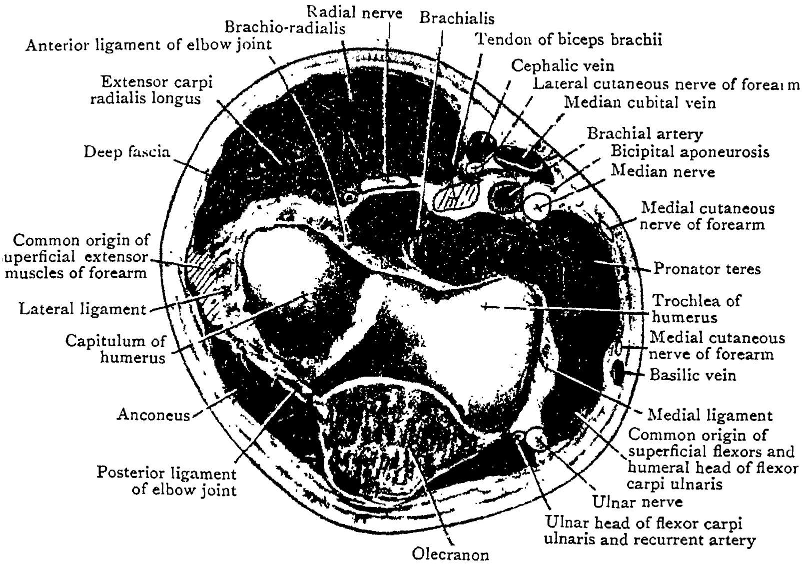

FIG. 73.—Transverse Section through Right Elbow, seen from below.

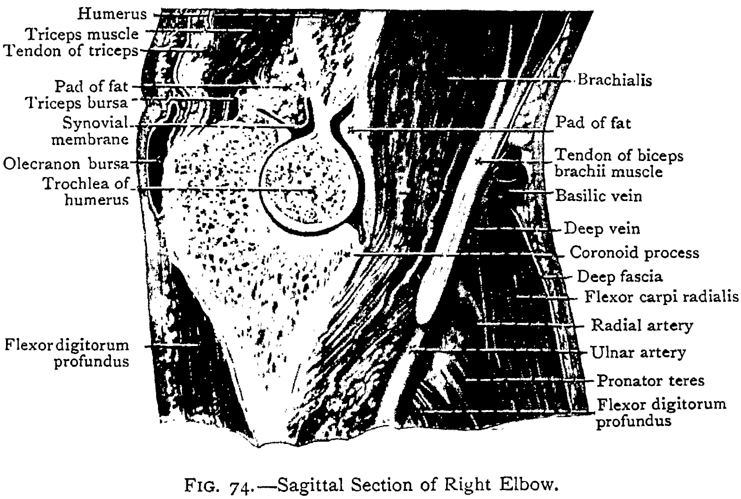

FIG. 74.—Sagittal Section of Right Elbow.

[*Facing p.* 154

PLATE XVI

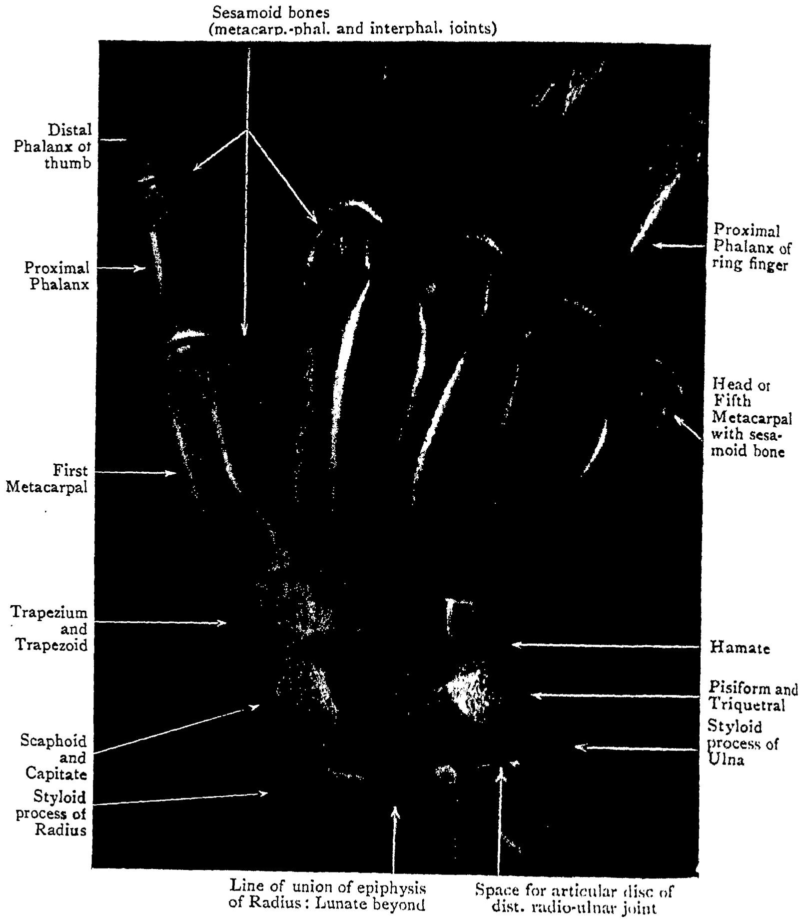

FIG. 75.—Radiograph of Wrist and Palm of girl aged 17.

The hand is in the position of adduction (ulnar flexion), though not complete; compare the position of the carpal bones, etc. in Fig. 97, Plate XXIII.

the terminal parts of the posterior interosseous nerve and anterior interosseous artery.

The *fifth compartment* is situated over the interval between

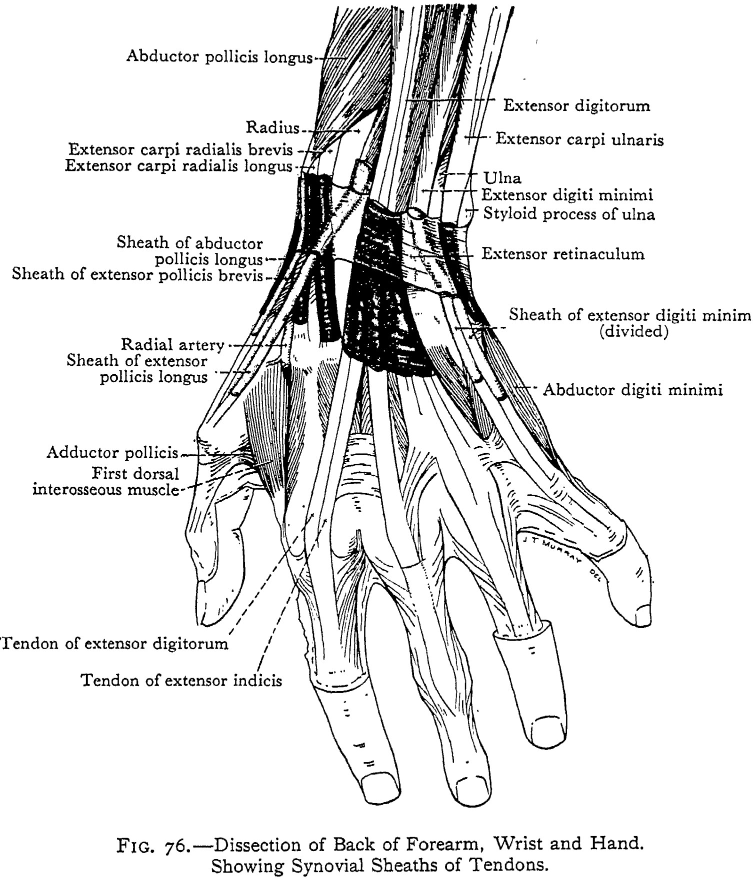

FIG. 76.—Dissection of Back of Forearm, Wrist and Hand. Showing Synovial Sheaths of Tendons.

the distal ends the of radius and ulna. It contains the tendon of the extensor digiti minimi.

The *sixth* and *most medial compartment*, which corresponds with the groove on the dorsum of the distal end of the ulna, encloses the tendon of the extensor carpi ulnaris.

Synovial Sheaths of Extensor Tendons (Figs. 71, 72, 76).—Eight synovial sheaths surround the tendons which pass through the six compartments under cover of the extensor retinaculum—each of the nine tendons having its own sheath, except the extensor digitorum and extensor indicis, which have a common sheath.

The upper ends of the sheaths are deep to the extensor retinaculum or slightly above it. The sheaths of the abductor pollicis longus and the three extensors of the carpus extend to the insertions of those muscles. The sheaths of the extensors of the digits usually end about the mid-length of the hand (Figs. 71, 76). Occasionally, the abductor pollicis longus and the extensor pollicis brevis have a common sheath; and sometimes a single sheath encloses the radial extensors of the wrist (see Fig. 72).

SUPERFICIAL MUSCLES.—The muscles of the superficial group were named on p. 152. They must now be cleaned.

> ***Dissection.***—The brachio-radialis has been dissected already. Clean the other superficial muscles and isolate them from one another. Their proximal parts are united by fascial septa. Split the septa with the knife, up to the bony origins of the muscles.

Anconeus.—The anconeus is a short, triangular muscle that lies at the lateral part of the back of the elbow. It arises, by a tendon, from the lateral epicondyle, and spreads out to be inserted into the lateral border of the olecranon (Fig. 73) and the upper third of the back of the shaft of the ulna (Fig. 79). The nerve of supply, a long slender branch of the *radial nerve* that reaches the muscle through the medial head of the triceps, has been noted already (p. 111 and Fig. 47). The anconeus is an extensor of the elbow joint.

Brachio-Radialis.—This muscle lies more on the front of the forearm than on the back. It takes origin, in the upper arm, from the upper two-thirds of the lateral supracondylar ridge. Near the middle of the forearm, a flat tendon emerges from its fleshy belly, and proceeds downwards to gain insertion into the lateral surface of the distal end of the radius, under cover of the tendons of the abductor pollicis longus and extensor pollicis brevis. The nerve of supply, a branch of the *radial nerve*, enters the muscle above the elbow. It can help to initiate supination of the prone forearm and pronation of the supine forearm, but its main action is flexion of the

elbow; flex your own forearm against resistance in the semi-prone position, and note how the muscle stands out.

Extensor Carpi Radialis Longus.—This muscle is placed behind the brachio-radialis. It arises from the distal third of the lateral supracondylar ridge. From the fleshy portion of the muscle a long tendon proceeds, which passes under cover of the extensor retinaculum and is inserted into the base of the second metacarpal bone. The muscle is supplied by a branch of the *radial nerve* which enters it above the elbow. It helps to extend and abduct the hand at the wrist joint (Figs. 71, 69, 76).

Common Extensor Tendon.—The four remaining superficial muscles—extensor carpi radialis brevis, extensor digitorum, extensor digiti minimi and extensor carpi ulnaris—have a *common origin* by means of a tendon attached to the lower part of the front of the lateral epicondyle.

Extensor Carpi Radialis Brevis.—The short radial extensor of the wrist is closely associated with the long extensor; its tendon accompanies that of the long extensor under cover of the extensor retinaculum, and is inserted into the base of the third metacarpal bone. This muscle is usually supplied from the *posterior interosseous nerve* before that nerve pierces the supinator muscle, but it may receive its nerve direct from the superficial division of the radial nerve. It is an extensor and abductor of the wrist.

Extensor Carpi Ulnaris.—The ulnar extensor of the wrist gains additional origin from the strong fascia that binds it to the posterior border of the ulna. The tendon does not become free from the fleshy fibres until it is near the wrist. It occupies the groove on the back of the distal end of the ulna, and, escaping from the extensor retinaculum, it is inserted into the base of the fifth metacarpal bone. The muscle is supplied by the *posterior interosseous nerve.* It is an extensor of the wrist and elbow; and it aids the flexor carpi ulnaris in adducting the hand.

Dissection.—Remove the deep fascia of the back of the hand. Clear away the synovial sheaths of the tendons, and clean the tendons as far as their insertions; but do not injure (1) the extensor retinaculum, (2) the blood-vessels which lie deep to the tendons and in the intervals between them, (3) the slips which connect the tendons to one another.

Note that the extensor tendon expands on the back of the first phalanx of a finger, but is not inserted into that phalanx. Lift

middle finger tendons. Because of that connexion and because the tendon for the little finger separates low down, the ring-finger has less independent movement than the others.

Each tendon spreads out to form the *extensor expansion*, which covers the whole of the back of the proximal phalanx. There, it receives part of the insertion of a lumbrical muscle and of either one or two interosseous muscles. The tendon of the index is joined by the extensor indicis also; and the tendon of the little finger by the extensor digiti minimi. On

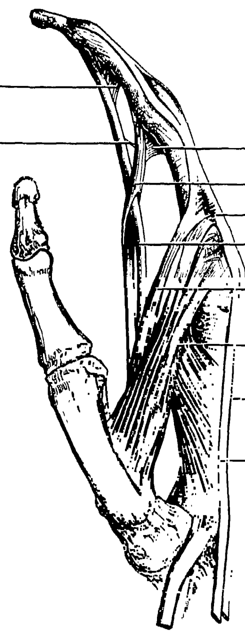

FIG. 78.—The Tendons attached to the Index Finger.

the back of the proximal phalanx, each expansion divides into three slips. The middle slip passes across the joint and carries the main insertion of the extensor into the base of the middle phalanx. The two collateral slips, formed chiefly by the tendons of interossei and lumbricals, converge over the middle phalanx, and unite to be inserted into the base of the terminal phalanx (Figs. 76, 78).

Extensor Digiti Minimi.—This slender muscle arises

in common with the extensor digitorum, lies along its medial side, and appears at first sight to be a part of it, but its tendon passes through a special compartment in the extensor retinaculum. The tendon splits into two parts (Fig. 76). The medial part takes the main share in forming the expansion on the first phalanx. The lateral part, before it joins the expansion, is joined by the tendon from the extensor digitorum. The muscle is supplied by the *posterior interosseous nerve.* It is an extensor of all the joints of the little finger; and it aids in extension of the wrist.

Movements of Fingers.—The dissector should now note the movements he can make with his own fingers.

(1) He can flex all three joints of the fingers—the metacarpo-phalangeal, and the proximal and distal interphalangeal joints as in "making a fist".

(2) He can extend all three joints.

(3) He can flex the interphalangeal joints with the fingers extended at the metacarpo-phalangeal joints; but he will find increasing difficulty in performing this movement with individual fingers as he proceeds from the index to the little finger.

(4) He can also flex the metacarpo-phalangeal joints and extend the interphalangeal joints. The last combination of movements is called "putting the fingers in the writing position". It is due mainly to the actions of the interossei and lumbricals, which pass from the front to the back across the metacarpo-phalangeal joints, and so are enabled to flex those joints; through their attachments to the extensor expansions they would appear to be able directly to extend the interphalangeal joints, but it has been shown that this is due to the ligamentous action of the extensor tendons (Whillis).

(5) Close the fist, and note that, though the fingers are unequal in length, their tips come into line and meet the palm with equal pressure. Note also that, as the fist is closed, the hand bends backwards—*i.e.*, it becomes extended or dorsiflexed at the wrist joint. This is due to the extensors of the wrist, for they now come into play partly as synergists to prevent the flexors from bending the wrist forward and partly as prime movers to dorsiflex the hand and thus enable the flexors to exert their full action on the fingers, which they can do only when the hand is dorsiflexed. It is because of this fact that, if the wrist joint has to be fixed owing to disease, it is put up in the dorsiflexed position in order that the fingers may retain their full grasping power. To test more fully how flexion of the fingers may be hampered by the position of the hand: flex the wrist joint as far as possible and then try to close the fist; it cannot be done, for the extensors will not stretch enough ("passive insufficiency") to allow complete flexion at all the joints. This fact explains the common trick by which one can force a person to release the grasp by suddenly flexing the wrist joint.

(6) Note, further, that, as the fist is closed, the fingers come together owing to the line of pull of the flexor tendons. Try to keep them apart; it is impossible: nor can they be separated while the fist is closed; though this is easily done (by the dorsal interossei, p. 170) with the fingers extended, or even partly flexed in various positions so long as *both* flexors are not fully in action.

(7) Flex one finger (*e.g.*, the middle finger) at the metacarpo-phalangeal joint and proximal inter-phalangeal joint. The distal phalanx is now quite lax: you can neither flex it nor extend it, for the flexor profundus cannot act easily on one finger separately, and the extensors cannot act on the distal phalanx without extending the middle phalanx at the same time. The surgeons take advantage of that when the distal phalanx is loosened by rupture of the extensor tendon at its base. They splint the finger in the flexed position to prevent the flexor profundus from bending the distal phalanx and thus increasing the interval between the torn ends of the extensor tendon; and they set the distal phalanx in the fully extended position to make the interval between the torn ends as small as possible.

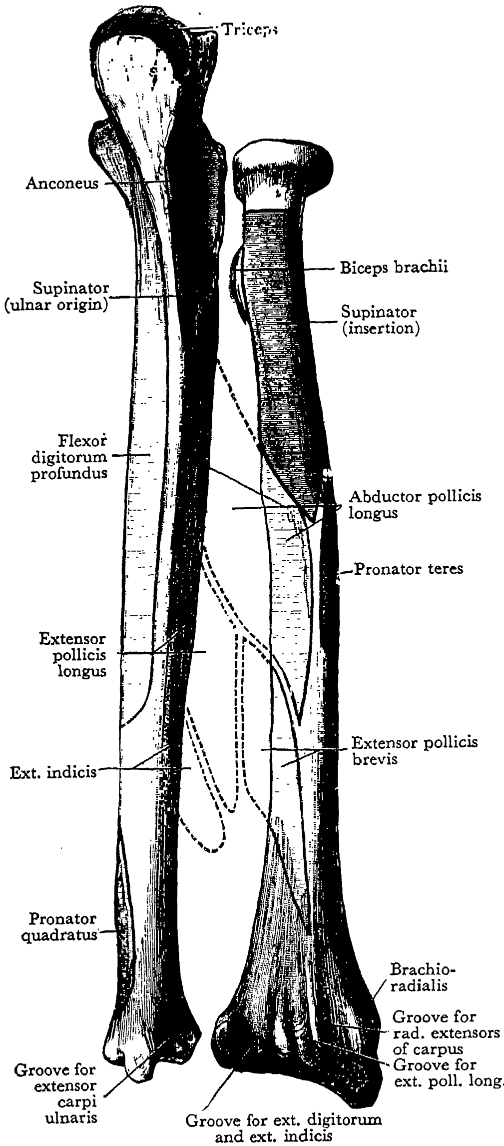

FIG. 79.—Back of Bones of Forearm, with Attachments of Muscles mapped out.

DEEP STRUCTURES OF BACK OF FOREARM (Figs. 69, 70, 79).—The deep structures are the posterior interosseous nerve

and vessels, the terminal part of the anterior interosseous vessels and the five deep muscles named on p. 152. The supinator will be recognised from the close manner in which it is applied to the upper part of the radius (Fig. 70); its attachments will be seen at a later stage (p. 171). The other muscles are recognised by means of their tendons, already identified.

Dissection.—Reflect the extensor digitorum and the extensor digiti minimi by dividing them about their middle and turning them upwards and downwards; as the muscles are reflected, secure their nerves. Pull aside the extensor carpi ulnaris. The greater parts of the *posterior interosseous vessels* and *nerve* and of the deep muscles will then be exposed.

Find the *posterior interosseous nerve* as it emerges from the supinator; follow it downwards among the muscles, and trace its branches to the muscles. In the lower part of the forearm, it lies very deeply and is joined by the *anterior interosseous artery.* Follow them to the retinaculum; split open the compartment through which the extensor digitorum and extensor indicis pass, and trace the nerve and artery to the back of the wrist.

Return to the *posterior interosseous artery* as it emerges between the supinator and the abductor pollicis longus, and follow it downwards.

Then, clean the muscles; define their origins; note where their tendons pass under the retinaculum; and trace the tendons to their insertions.

Abductor Pollicis Longus.—The long abductor of the thumb arises from the back of the interosseous membrane and both bones of the forearm. The muscle proceeds downwards and laterally, and comes to the surface in the interval between the extensor digitorum and the extensor carpi radialis brevis. It then crosses the two radial extensors, closely accompanied by the extensor pollicis brevis. Its tendon continues downwards, over the lateral side of the distal end of the radius and under cover of the extensor retinaculum, and is inserted into the base of the metacarpal bone of the thumb.

The muscle is supplied by the *posterior interosseous nerve.* In addition to being an abductor of the thumb, it assists in abduction of the hand; and its subsidiary power of *flexion* at the wrist joint may become of importance in median and ulnar paralysis.

Extensor Pollicis Brevis.—The short extensor, arising from a small portion of the posterior surface of the radius, and also from the interosseous membrane is placed along the distal border of the preceding muscle. The two tendons,

closely applied to each other, cross the wrist in the same compartment of the extensor retinaculum; and the tendon of the extensor pollicis brevis then passes along the back of the metacarpal bone of the thumb, to be inserted into the base of the proximal phalanx.

The muscle is supplied by the *posterior interosseous nerve.* It is an extensor of the carpo-metacarpal and metacarpo-phalangeal joints of the thumb.

Extensor Pollicis Longus.—The long extensor of the thumb takes origin from the posterior surface of the middle third of the ulna, and also from the interosseous membrane. It overlaps the preceding muscle to some extent, and it ends in a tendon which, passing under cover of the extensor retinaculum, occupies a deep, narrow groove on the back of the distal end of the radius. This groove is medial to the dorsal tubercle of the radius which acts as a sort of pulley for the tendon, enabling it to alter its direction and take an oblique course on the carpus. After crossing the tendons of the two radial extensors and the radial artery, it proceeds along the back of the thumb, and is inserted into the base of its distal phalanx.

It is supplied by the *posterior interosseous nerve.* It is an extensor of all the joints of the thumb.

Extensor Indicis.—The special extensor of the fore-finger arises, distal to the preceding muscle, from a limited area on the back of the ulna and the interosseous membrane. Its tendon accompanies the tendons of the extensor digitorum under cover of the extensor retinaculum, and is enclosed in the same synovial sheath. On the dorsum of the hand, it lies along the medial side of the most lateral tendon of the common extensor, and it terminates in the expansion of that tendon on the dorsum of the first phalanx of the index finger.

It is supplied by the *posterior interosseous nerve.*

Posterior Interosseous Nerve.—This is the deep division of the radial nerve and springs from it opposite the lateral epicondyle of the humerus (p. 123). It descends across the lateral part of the front of the elbow joint, under cover of the brachio-radialis muscle, gives branches to the extensor carpi radialis brevis and to the supinator, and then disappears into the supinator. It reaches the back of the forearm by traversing the substance of the supinator obliquely, and at the same time winding round the lateral side of the shaft of the radius. It emerges from the supinator a short distance above

the lower border of the muscle, and passes downwards, with the posterior interosseous vessels, across the surface of the abductor pollicis longus, under cover of the extensor digitorum.

It leaves the vessels by passing under cover of the extensor pollicis longus, and is joined by the anterior interosseous artery on the back of the interosseous membrane. Together they pass over the back of the distal end of the radius, deep to the synovial sheath of the extensor digitorum, to the back of the wrist joint. There the nerve ends in a slight swelling which sends branches to the wrist joint and to the intercarpal joints.

The branches of the posterior interosseous nerve are very numerous, and they supply muscles and joints.

The *articular* branches are distributed to the elbow, distal radio-ulnar, wrist and intercarpal joints.

The *muscular* branches that arise in front of the elbow supply the extensor carpi radialis brevis and supinator; those that arise in the back of the forearm supply all the other muscles there, including an occasional additional twig to the anconeus.

It supplies, therefore, all the muscles on the lateral side and the back of the forearm, with the exception of the brachio-radialis and the extensor carpi radialis longus, and occasionally the brevis (p. 157), which derive their nerve-supply directly from the *radial nerve*.

Posterior Interosseous Artery.—This artery arises, in the front of the forearm, from the common interosseous branch of the ulnar artery, and proceeds backwards at once between the two bones of the forearm immediately above the interosseous membrane. It appears in the back of the forearm between the supinator and the abductor pollicis longus, and then runs downwards between the superficial and deep muscles. It reaches the back of the wrist; but its lower part is so slender that it can seldom be traced below the middle of the forearm unless it is exceptionally well injected. It gives off branches to the adjacent muscles, and takes part through the *interosseous recurrent artery* in the anastomosis around the elbow (Figs. 70, 80).

Terminal Part of Anterior Interosseous Artery.—The anterior interosseous artery is larger than the posterior even after it reaches the back of the forearm. It perforates the interosseous membrane about two inches above

the distal end of the radius, and is at once joined by the posterior interosseous nerve. It descends, with the nerve, to the dorsum of the carpus, where it joins the *posterior carpal arch* (p. 166).

Tendons at the Wrist in the Living Limb.—Now that the flexor and extensor tendons have been examined in the dissected limb, proceed to examine them at the wrist and the distal part of the forearm in your own limb. First, make sure that you can identify the bony landmarks at the wrist (pp. 67-70); and then proceed to identify the tendons :—

1. Flexor carpi radialis and palmaris longus, at the middle in front. (The palmaris longus may be absent.)
2. Flexor carpi ulnaris, along the medial margin of the front of the distal part of forearm, ending in the pisiform bone.
3. The tendons of flexor superficialis rise into view, between the flexor carpi ulnaris and the palmaris longus, when the fist is clenched and the hand is bent forwards ; relax the tension of the fingers and the tendon of the flexor carpi radialis springs forward.
4. Abductor pollicis longus and extensor pollicis brevis lie close together in the anterior boundary of the " snuff-box ", and form a prominent ridge when the thumb is extended. Extensor pollicis longus, running obliquely towards the thumb, lies in the posterior boundary.
5. Extensor carpi radialis longus and brevis are crossed and partly hidden by the extensor pollicis longus, but they rise better into view when the fist is closed, for they then contract to prevent the flexors of the fingers from flexing the wrist also ; the brevis stands out more prominently than the longus.
6. Extensor indicis and extensor digitorum lie at the middle of the back of the wrist ; the diverging tendons of digitorum are seen best when the flexed fingers are extended at the metacarpo-phalangeal joints.
7. Extensor digiti minimi lies close to the radial side of the head of the ulna, but is not visible till it enters the hand.
8. Extensor carpi ulnaris, escaping from the groove between the head and the styloid process of the ulna, forms a thick, indistinct ridge at the ulnar margin of the back of the wrist.

On the back of the hand the radial artery and its branches have still to be examined ; and thereafter the anastomosis around the elbow joint should be reviewed.

Dissection.—Clean the part of the radial artery that lies on the radial side of the wrist with its branches, displacing the tendons as required.

Radial Artery.—Only a small portion of the radial artery is seen in this dissection. At the distal end of the radius, the vessel leaves the front of the forearm, turns backwards below the styloid process of the radius, and then descends

over the scaphoid and trapezium to reach the proximal end of the first interosseous space. There, it turns forwards through the space, between the two heads of the first dorsal interosseous muscle, to enter the palm (p. 150 and Fig. 57).

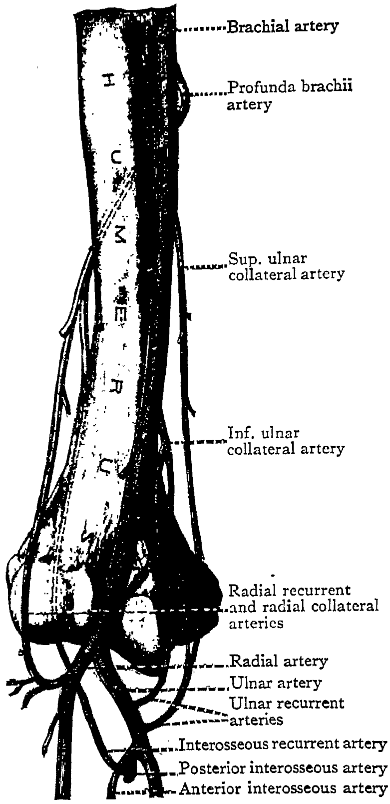

FIG. 80.—Diagram of Anastomosis around Elbow Joint. (Cf. Fig. 81.)

As it turns backwards below the radius, it lies on the lateral ligament of the wrist joint, and is crossed by the tendons of the abductor pollicis longus and extensor pollicis brevis. It crosses the carpus in the floor of the "anatomical snuff-box", where it can be felt pulsating. Note in your own hand that the commencement of the cephalic vein overlies it, and may be seen through the skin. Before the artery disappears it is crossed by the extensor pollicis longus and digital branches of the radial nerve.

The *branches* which spring from the radial artery in this part of its course are of small size; they supply the structures on the back of the hand and digits.

The *posterior carpal artery* joins the similar branch of the ulnar artery to form the *posterior carpal arch*, from which two *dorsal metacarpal arteries* run towards the clefts between the medial three fingers, where each divides into two small *dorsal digital arteries* for the adjacent sides of the fingers. The *first dorsal metacarpal artery* may arise in common with the posterior carpal artery, and goes to the cleft between the forefinger and middle finger.

Each dorsal metacarpal artery sends two *perforating arteries* forwards

FIG. 81.—Radiograph of Elbow Region after injection of the Arteries with radio-opaque material (from positive print). Cf. Fig. 80. The median artery (cf. Fig. 54) is larger than usual.

[*Facing p.* 166

PLATE XVIII

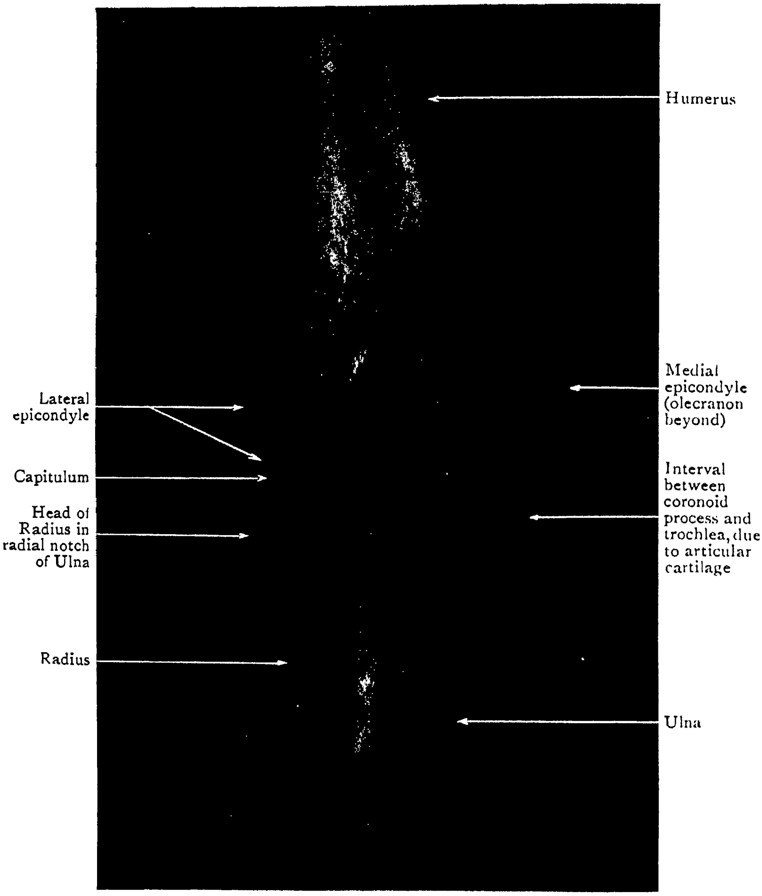

FIG. 82.—Radiograph of Elbow of young woman aged 19.

[*Facing p.* 167

through the interosseous space to connect it with the deep palmar arch and with a palmar digital artery.

The *dorsal digital arteries for the thumb* and *radial side of the forefinger* arise independently from the radial artery before it disappears into the palm.

> *Dissection.*—Detach the anconeus from its origin, turn it downwards and trace the interosseous recurrent artery to the back of the lateral epicondyle.

Anastomosis around the Elbow Joint.—Small vessels that arise from the brachial, radial and ulnar arteries have already been traced to the elbow where they ramify and anastomose to form a rich network around the elbow. The branches that arise from the network supply the bones, ligaments and synovial membrane of the elbow and proximal radio-ulnar joints and also the structures around the joints.

Note in Fig. 80 the level of origin of the various arteries that take part in the anastomosis, in relation to the re-establishment of circulation after ligature of the main vessels at any point ; and compare with Fig. 81.

The vessels of the lateral and medial sides communicate freely, and the chief transverse anastomosis arches across the back of the humerus immediately above the olecranon fossa.

Deepest Structures in Palm and Forearm

The structures that remain to be examined, before the joints are dissected, are the *deep transverse metacarpal ligaments*, the *interosseous muscles*, the tendon of the *flexor carpi radialis*, and the *supinator muscle*.

> *Dissection.*—Complete the dissection of the palm by defining the *deep transverse ligaments*. They are found in the spaces between the heads of the metacarpal bones by displacing the lumbrical muscle and the digital nerves and artery.

Deep Transverse Metacarpal Ligaments.—This name is given to the three strong, short, flat bands that lie between the heads of the metacarpal bones of the fingers. At each side, they are attached to the margins of the palmar ligaments of the metacarpo-phalangeal joints. The slips of the palmar aponeurosis gain partial attachment to their palmar surfaces. The lumbrical muscles and digital vessels and nerves lie in front of them. The interosseous muscles lie behind them. Though they are not directly fixed to bones, their connexion with the palmar ligaments of the joints (which are very strong) enables them to prevent excessive separation of the metacarpal bones from one another.

> *Dissection.*—The interosseous muscles have been partly exposed already. To expose them fully, draw the flexor tendons, the lumbricals and the digital nerves and vessels out of the way, remove the transverse head of the adductor pollicis from the

third metacarpal bone, and divide the deep transverse metacarpal ligaments. Clean the interosseous muscles, define their margins, and follow their tendons backwards to their insertions.

Mm. Interossei.—The interosseous muscles (Figs. 56, 83, 84) occupy the intervals between the metacarpal bones, and to a large extent conceal their palmar aspects. They are arranged in two groups—a palmar and a dorsal—four in each group. The palmar interossei are seen only in the palm. The dorsal

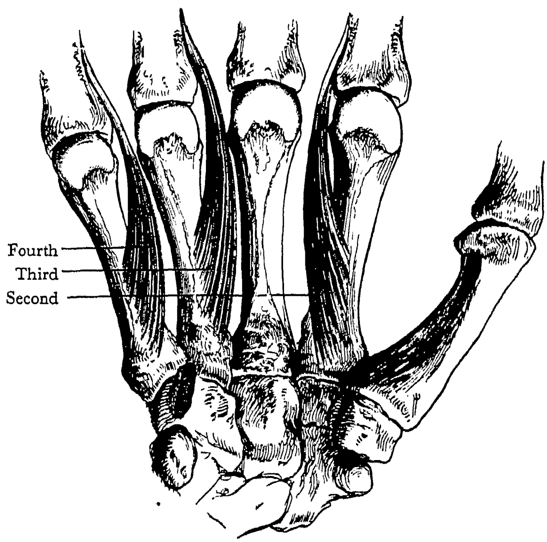

FIG. 83.—Palmar Interosseous Muscles of Right Hand.
For 1st palmar interosseous, see Fig. 84.

interossei are seen best on the back of the hand, but are visible in the palm also.

Except the first palmar, they are all bound to the capsule of a metacarpo-phalangeal joint and are inserted chiefly into the extensor expansion on the back of the proximal phalanx, but have also a loose connexion with the base of that phalanx.

Since their tendons pass backwards across a metacarpo-phalangeal joint to reach insertion, they flex that joint; and, since they are inserted by means of the extensor expansion into the base of the terminal phalanx, they would seem to be able to

extend the interphalangeal joints—but see p. 160. In addition, they either abduct the fingers from the middle line of the middle finger or adduct them towards it, according to which side of the metacarpo-phalangeal joint they cross.

The *first palmar interosseous muscle* (Fig. 84) is a very slender slip and is not always found. It lies between the adductor pollicis and the first dorsal interosseous muscle, and stretches from the ulnar side of the base of the first metacarpal

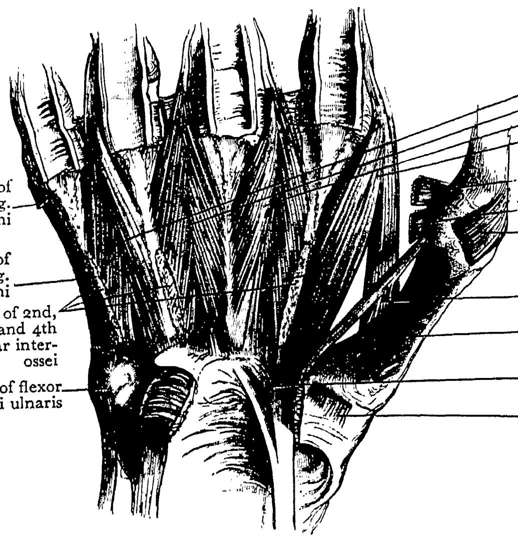

FIG. 84.—Dorsal Interosseous Muscles of Right Hand (seen from the Palmar Aspect).

bone to the ulnar side of the base of the first phalanx of the thumb.

The *second*, *third* and *fourth palmar interossei* act on the forefinger, the ring-finger and the little finger. Each arises from the palmar aspect of the metacarpal bone of the finger on which it acts. They flex and extend these fingers in the way described above; and they *adduct* them towards the middle finger. Therefore, the second crosses the medial side of the root of the forefinger, and the others cross the lateral sides of their respective fingers.

The four *dorsal interossei* lie in the four interosseous spaces

and are seen therefore both in the palm and on the back of the hand. Each arises by two heads from the two metacarpal bones between which it lies, the heads converging on the tendon in bipennate fashion. They act on the forefinger, the middle finger and the ring-finger—the middle finger giving insertion to two of them. Like the palmar interossei, they flex and extend, but *abduction* from the line of the middle finger is their additional action. The *first* is inserted on the lateral side of the forefinger; the *fourth* is inserted into the medial side of the ring-finger. The *second* and *third* are inserted into opposite sides of the middle finger, and each of these two acts alternately as an abductor and an adductor of that finger.

Each finger is provided, therefore, with an abductor and an adductor. The forefinger, the middle finger and the ring-finger have each two interossei that abduct and adduct them. The little finger has a special abductor, and the fourth palmar interosseous muscle is its adductor. The thumb has its own abductors and adductor.

The dorsal interossei are larger than the palmar. The *first* dorsal interosseous is the largest of them. It is the fleshy mass seen on the back of the hand between the metacarpal bones of the thumb and forefinger. Its action as an abductor of the forefinger, as a flexor of the metacarpo-phalangeal joint and an extensor of the interphalangeal joints can be tested in your own hand. Indeed, it is a useful exercise to spread the hand on the table, abducting and adducting the fingers in turn and naming the muscles concerned.

The interossei are all supplied by the *deep palmar branch of the ulnar nerve* (T. 1); and, since they act as extensors and flexors of different joints of the fingers, the hand assumes a peculiar shape in ulnar paralysis. When the interossei are paralysed, the balanced action of the opposing sets of muscles is upset. Through the loss of the action of the interossei on the metacarpo-phalangeal joints, the extensors bend the fingers backwards at those joints. But, at the same time, the flexors bend the fingers forward at the interphalangeal joints, which the interossei usually extend. The result is the "main en griffe" or claw-hand.

Dissection.—Clear away the thenar muscles from the flexor retinaculum; displace the tendon of the flexor pollicis longus; and remove the oblique head of the adductor pollicis from its

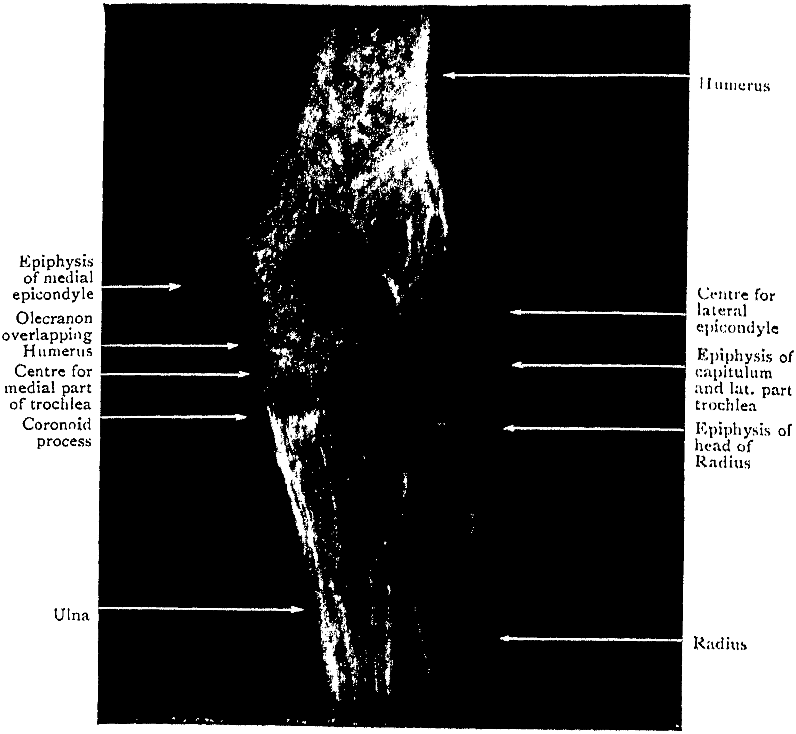

FIG. 85.—Radiograph of Elbow of boy aged 12, showing all epiphysial centres. The three centres for (1) capitulum and lateral part of trochlea, (2) medial part of trochlea, and (3) lateral epicondyle, unite to form a single epiphysis.

Note the olecranon epiphysis above the part of the olecranon that overlaps the Humerus. Cf. Figs. 86 and 87 for earlier and later stages of development of epiphyses.

PLATE XX

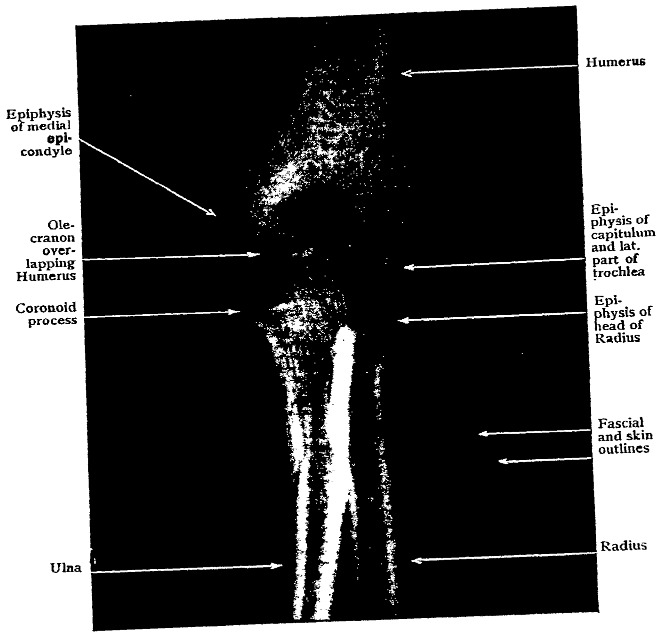

FIG. 86.—Radiograph of Elbow of boy aged 7. Note that centre for capitulum forms part of the trochlea, and that the other trochlear centre and the lateral epicondyle centre have not yet appeared. For later stages of development of the epiphyses, see Figs. 85, 87.

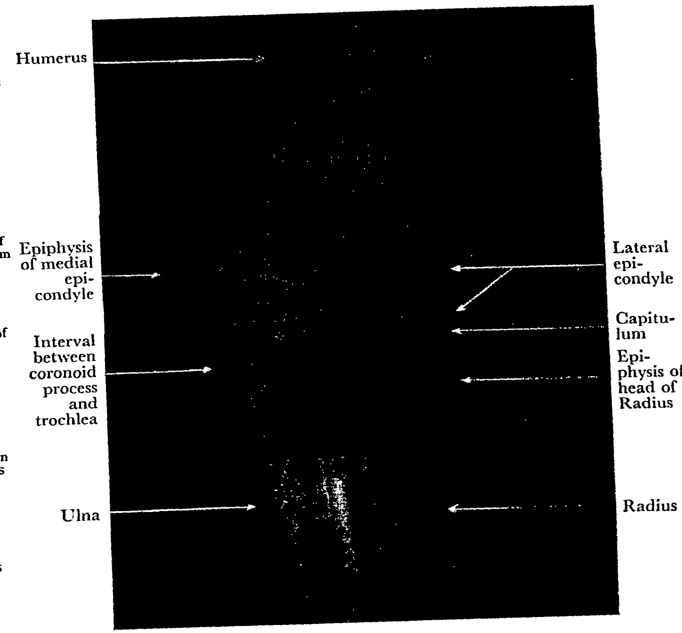

FIG. 87.—Radiograph of Elbow of girl aged 12, showing epiphyses of medial epicondyle of Humerus and head of Radius not yet united. For earlier stages of development of the epiphyses, see Figs. 85, 86.

[*Facing p.* 171

origin. Pull on the tendon of the flexor carpi radialis, and rip through the part of the retinaculum that covers it. Examine the synovial sheath of the tendon, and clean it down to its insertion.

Tendon of Flexor Carpi Radialis.—When this tendon reaches the wrist, it crosses in front of the tubercle of the scaphoid bone, and descends in the groove on the front of the trapezium, covered by the retinaculum and by the origins of the thenar muscles. Leaving the groove, it passes to its insertion into the base of the second metacarpal bone; and that part is covered by a prolongation of the retinaculum, and by a part of the origin of the adductor pollicis. The tendon of the flexor pollicis longus has a double relation to it: that tendon crosses behind it at the wrist joint, and in front of it near its insertion.

***Dissection.*—All the muscles around the elbow joint should be removed. As the brachialis and the triceps are raised, some care is required to avoid injury to the anterior and posterior parts of the capsule. Leave the supinator to the last, because it is only when it is completely isolated that a proper idea of its attachments and mode of action can be obtained.**

Supinator.—This muscle envelops the neck and the proximal part of the shaft of the radius, covering it completely, except on its medial side (Figs. 44, 61, 70, 79). It arises chiefly from the floor of the deep depression below the radial notch of the ulna. From their origin, the fibres sweep round the radius, and clothe its shaft as far down as the insertion of the pronator teres. The posterior interosseous nerve supplies the muscle, traverses its substance, and partially separates it into two layers.

JOINTS OF UPPER LIMB

The **clavicular joints** and the **shoulder joint** have been already dissected (pp. 46, 97, 113).

Elbow Joint

The **elbow joint** is the articulation of the humerus with the radius and the ulna. The trochlea of the humerus is grasped by the trochlear notch of the ulna; the capitulum of the humerus rests on the upper surface of the head of the radius.

It is an example of the *hinge* variety of synovial joints.

Ligaments.—The **fibrous capsule** encloses the joint and is thickened at the sides to form *collateral ligaments* ; the anterior and posterior parts are not specially thickened, but they are called the *anterior* and *posterior ligaments.*

The *anterior ligament* is a thin membrane, but is fairly strong. Its attachment to the humerus is to the epicondyles

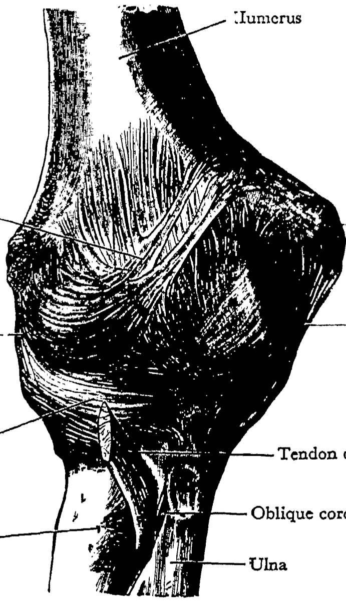

FIG. 88.—Anterior aspect of Right Elbow Joint.

and along the upper margins of the radial and coronoid fossæ. Below, it is attached to the coronoid process of the ulna and to the annular ligament of the radius—a strong band that loops round the head of the radius.

The *posterior ligament* is weak, especially medially. It stretches from a line joining the epicondyles across the floor of the olecranon fossa, where its attachment is very loose, to the edge of the olecranon.

The *radial collateral ligament* is a strong, short band which is attached to the lower surface of the lateral epicondyle, and

spreads out inferiorly to be fixed to the lateral and posterior parts of the annular ligament.

The *ulnar collateral ligament* radiates from the lower border of the medial epicondyle to the medial margins of the coronoid process and olecranon and to an oblique band that bridges across the interval between those margins. The anterior and posterior parts of this radiating ligament are thick ; the middle part, which is attached to the oblique band, is thin. The ulnar nerve, as it descends from the back of the

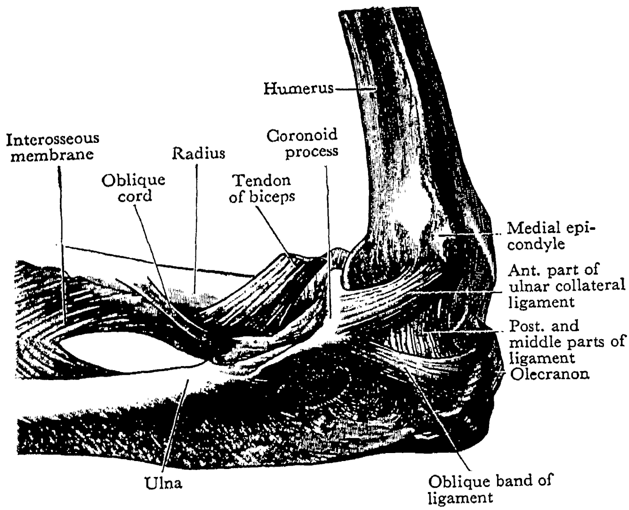

FIG. 89.—Medial aspect of Right Elbow Joint.

medial epicondyle into the forearm, lies on the posterior and middle parts of the ligament, and the posterior ulnar recurrent artery ascends close by the nerve.

***Dissection.*—Make transverse incisions through the anterior and posterior parts of the capsule, and examine the synovial membrane.**

Synovial Membrane.—The synovial membrane lines the deep surface of the fibrous capsule. *Superiorly*, it is reflected on to the humerus to cover the non-articular part of the bone enclosed within the fibrous capsule ; and it ends by overlapping the margins of the articular capitulum and trochlea.

As it passes over the floor of the olecranon fossa, it is separated from the bone by a little oily fat. Opposite the olecranon fossa and the coronoid and radial fossæ, it is separated from the fibrous capsule by pads of fat (Fig. 74) which bulge it into the fossæ when the bony processes are withdrawn.

Inferiorly, at the back and at the front and at the medial side, it passes off the fibrous capsule to overlap the articular margins of the coronoid process and the olecranon ; but, at the lateral side, it is directly continuous with the synovial membrane of the proximal radio-ulnar joint.

The *nerve supply* of the joint is derived from the median, musculo-cutaneous, ulnar, radial and posterior interosseous

The *structures related* to the surfaces of the joint are shown in section in Fig. 74.

Movements at the Elbow Joint.—The movements at the elbow joint are distinct from those that take place at the proximal radio-ulnar joint. Since it is a hinge joint there are two movements only—*flexion* or forward movement of the forearm, and *extension* or backward movement after flexion; in full "extension" the arm is in the straight position.

The *muscles* which are chiefly concerned in flexing the forearm are the biceps, brachialis, brachio-radialis and pronator teres; these muscles are assisted, to a slight extent, by the other muscles attached to the medial epicondyle. The muscles which extend the forearm are the triceps and the anconeus, aided slightly by the muscles which spring from the lateral epicondyle.

It is advisable to study the wrist joint before the radio-ulnar joints are examined.

***Dissection.*—Cut away the remains of the thenar and hypothenar muscles. Remove the flexor and extensor retinacula and the flexor and extensor tendons from the wrist—but do not detach the tendons from the digits.**

Wrist Joint

The **radio-carpal** or **wrist joint** is the joint between the forearm and the hand. The proximal face of the joint is formed by the lower articular surface of the radius and the articular disc; and the distal face by the scaphoid, lunate and triquetral bones, with their interosseous ligaments.

Ligaments.—The opposed surfaces of the joint are retained in apposition by its **fibrous capsule** which is attached, proximally, to the borders of the distal ends of the radius and the ulna, including the styloid processes, and to the borders of

the articular disc. Distally, it is connected with the bones of the proximal row of the carpus (with the exception of the pisiform) and some of its fibres can be traced to the capitate bone.

Four thickened bands can be recognised, namely:— Anterior and posterior radio-carpal, radial and ulnar collateral ligaments of wrist. Their individual attachments correspond to their positions on the front, back and sides of the joint.

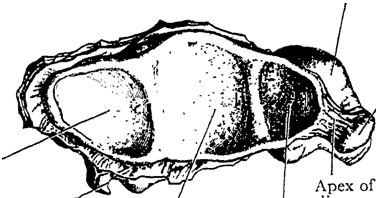

FIG. 90.—Carpal Articular Surfaces of Radius and Articular Disc of Right Wrist.

Dissection.—**Divide the anterior, medial and lateral ligaments by a transverse incision across the front of the joint. Bend the hand backwards to expose the articular surfaces.**

Articular Surfaces.—The *carpal surface* (Fig. 93) is composed of the proximal articular facets of the scaphoid and lunate bones, and a very small articular facet on the extreme lateral part of the proximal surface of the triquetral. Interosseous ligaments stretch across the intervals between the three bones and complete the carpal surface, which is convex in all directions. Further, the articular surface extends downwards to a greater extent on the back than on the front.

The *proximal surface* or *socket* (Figs. 90, 91) is elongated from side to side, and concave in all directions. The greater part of it is formed by the distal end of the radius, but it is extended on the medial side by the articular disc of the distal radio-ulnar joint (p. 178), which excludes the distal surface of the ulna from the wrist joint (Fig. 93). The distal articular surface of the radius extends lower down behind and laterally than in front and medially; and it is divided by a low ridge

into two facets—a lateral triangular and a medial quadrilateral —corresponding, in the ordinary position of the hand, with the scaphoid and part of the lunate bone.

When the hand is placed in line with the forearm no part of the proximal articular surface is in contact with the triquetral: its small articular facet rests against the medial part of the capsule of the joint. When the hand is adducted, however, the triquetral bone travels laterally, and its articular surface comes into contact with the distal surface of the articular disc. The lunate bone at the same time crosses the ridge on the distal surface of the radius, whilst a considerable part of the surface of the scaphoid bone leaves the radius and comes into contact with the lateral part of the capsule (Fig. 75). The interval that is seen in radiographs (Figs. 94B, 97) between the ulna and the triquetral is obviously due mainly to the presence of the articular disc.

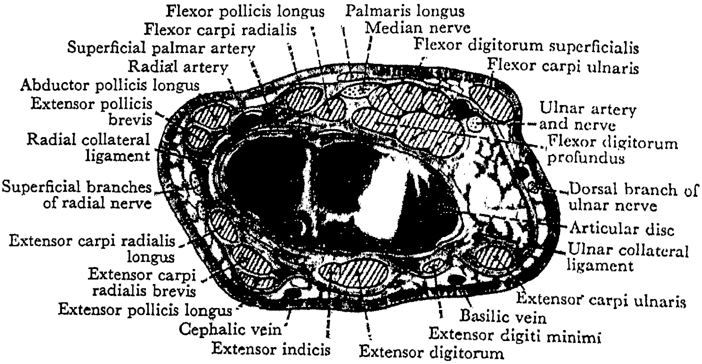

FIG. 91.—Transverse Section through Right Wrist Joint, seen from below.

Synovial Membrane.—The synovial membrane lines the fibrous capsule and covers the two interosseous ligaments which complete the carpal surface. Sometimes the articular disc is imperfect; the synovial membrane of the radio-carpal joint is then continuous with the synovial membrane of the distal radio-ulnar joint.

The ***nerve supply*** is derived from the anterior and posterior interosseous nerves and the dorsal branch of the ulnar nerve. The *structures related* to the joint are shown in Fig. 91.

Movements at the Radio-Carpal Joint.—The hand can be moved in four directions at the wrist joint. We have thus:—(*a*) forward movement or *flexion*; (*b*) backward movement or *extension*; (*c*) medial movement or *adduction*; (*d*) lateral movement or *abduction*. In estimating the extent of these movements in the living person, the student is

liable to be misled by the increase of range contributed by the intercarpal joints. Thus, flexion is in reality more limited than extension, although by the added movements of intercarpal joints the hand can be carried much more freely forwards than backwards. Adduction can be produced to a greater extent than abduction, for the styloid process of the radius interferes with abduction. In both cases the extent of movement at the radio-carpal joint proper is relatively slight, and the range is extended by movements of the carpal bones. *Circumduction* is the circular movement brought about by the four movements in sequence, *e.g.*, extension, abduction, flexion and adduction.

The *muscles* which are chiefly concerned in producing the different movements of the hand at this joint are the following :—(*a*) *Flexors*—flexor carpi radialis, palmaris longus, and flexor carpi ulnaris; (*b*) *Extensors*—extensor carpi radialis longus, extensor carpi radialis brevis, and extensor carpi ulnaris; (*c*) *Abductors*—flexor carpi radialis, extensor carpi radialis longus, abductor pollicis longus, and extensor pollicis brevis; (*d*) *Adductors*—extensor carpi ulnaris and flexor carpi ulnaris. Note the various combinations in which these muscles can act, *e.g.*, two muscles that act alternately as prime movers and antagonists in flexion and extension act together as prime movers in adduction.

In addition, all the muscles whose tendons cross the front of the joint (including abductor pollicis longus, p. 162) can, under certain conditions, assist in flexion, and the muscles whose tendons cross the back can assist in extension.

Radio-Ulnar Joints

At the two radio-ulnar joints—proximal and distal—the movements of pronation and supination take place.

Proximal Radio-Ulnar Joint.—At this joint, the medial part of the head of the radius fits into the radial notch of the ulna ; and its *ligaments* are the *annular* and the *quadrate.*

Annular Ligament of Radius.—This is a strong, fibrous collar which encircles the head of the radius and retains it in the radial notch of the ulna. It forms four-fifths of a circle, and is attached by its extremities to the anterior and posterior margins of the notch. It is slightly narrower below than above, and therefore, under ordinary circumstances, the head of the radius cannot be pulled downwards out of it; and the ligament is braced tightly towards the elbow and also greatly strengthened by the anterior and lateral ligaments of the elbow, which are attached to its upper border. Its lower border is attached, loosely, to the neck of the radius by a thin layer of fibrous tissue which closes the joint inferiorly—except at the medial side, where the closure is completed by the *quadrate ligament*, a small, loose, weak sheet of fibres that connects the neck of the radius to the lower margin of the radial notch of the ulna.

Synovial Membrane.—The synovial membrane of the proximal radio-ulnar joint is a prolongation downwards of the synovial membrane of the elbow joint; it lines the deep surface of the annular ligament and the upper surface of the quadrate ligament. As it is reflected upwards to reach the articular cartilage around the head of the radius, it encloses the intracapsular part of the neck in a tubular sheath.

Distal Radio-Ulnar Joint.—At this joint, the head of the ulna is received into the ulnar notch of the radius; and

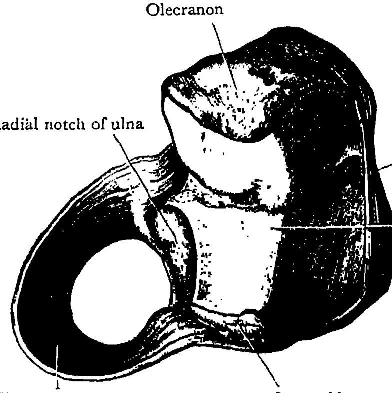

FIG. 92.—Annular Ligament of Radius.

the bones are united by a fibrous capsule and the *articular disc.*

Articular Disc.—The disc is the true bond of union at this joint. It has already been noticed in connection with the radio-carpal joint, where it extends the radial articular surface in a medial direction; it separates the distal end of the ulna from the lunate and triquetral bones, and intervenes, therefore, between the cavities of the wrist joint and distal radio-ulnar joint (Fig. 93). It is a thick, firm, fibro-cartilaginous plate of triangular outline, attached by its base to the distal margin of the ulnar notch of the radius, and by its apex to the depression at the root of the styloid process of the ulna.

Articular Capsule.—The *fibrous capsule* consists of lax fibres which can have little influence in retaining the distal ends of the bones in apposition. It is attached to the anterior

and posterior borders of the articular disc, and to the front and back of both bones of the forearm, extending upwards to the lower ends of their interosseous borders to enclose an upward prolongation of the cavity of the joint called the *recessus sacciformis*.

The *synovial membrane* lines the fibrous capsule, and covers the upper surface of the disc.

In addition to the ligaments of the two joints, the bones are held together by the *interosseous membrane*.

Dissection.—To expose the interosseous membrane, remove the muscles from the back and the front of the forearm.

Interosseous Membrane of Forearm.—The interosseous membrane is a fibrous sheet that stretches across the interval between the two bones of the forearm, and is attached to the interosseous border of each. Its upper border is situated about one inch below the tuberosity of the radius. Distally, it blends with the capsule of the distal radio-ulnar joint. The posterior interosseous vessels pass backwards, above its upper margin, between the two bones of the forearm; and the anterior interosseous vessels pierce it about two inches from its distal end.

Its fibres run for the most part obliquely downwards and medially from the radius to the ulna, although several strands may be noticed taking an opposite direction. The membrane therefore braces the two bones together in such a manner that forces, passing upwards from the hand through the radius, are transmitted from the radius to the ulna. It also extends the surface of origin for the muscles of the forearm. By its anterior surface, it gives origin to the flexor digitorum profundus and the flexor pollicis longus muscles, whilst from its posterior surface spring fibres of the two extensor muscles of the thumb, the abductor pollicis longus, and the extensor indicis.

Dissection.—Cut through the annular ligament, divide the interosseous membrane from above downwards, open the capsule of the distal radio-ulnar joint, and draw the radius laterally. Examine the connexions of the capsule and articular disc.

Movements at the Radio-Ulnar Joints.—The movements of pronation and supination take place at the radio-ulnar joints. When the limb is in the position of complete supination, the thumb is directed laterally,

and the two bones of the forearm are parallel. In the movement of pronation, the radius is thrown across the front of the ulna, so that its distal end comes to lie on the medial side of the ulna. Further, the hand moves with the radius, and when the movement is completed the back of the hand is directed forwards, and the thumb is turned medially.

The dissector should study the movements at the two radio-ulnar joints in the dissected part. But the range of movement in a completely dissected limb is apt to be deceptive; it should therefore be checked by observation of the living limb.

In the *proximal radio-ulnar joint*, the movement is simple enough. The head of the radius merely rotates within the annular ligament; and accuracy of motion is obtained by the head of the radius resting and moving upon the distal end of the humerus (Figs. 82, 95A, 95B).

At the *distal radio-ulnar joint*, the distal end of the radius revolves around the distal end of the ulna. It carries the hand with it, and describes the arc of a circle whose centre is at the attachment of the articular disc to the distal end of the ulna. As the movement occurs, the articular disc moves with the radius, and travels backwards on the distal end of the ulna in supination, and forwards in pronation.

The muscles chiefly concerned in *supination* of the forearm are the biceps brachii and the supinator, aided by the long abductor, the long extensor of the thumb and the brachio-radialis. The biceps brachii, from ts insertion into the posterior part of the tuberosity of the radius, is placed in a very favourable position for supinating.

The *pronators* are the pronator teres, the pronator quadratus, and, to a certain extent, the flexor carpi radialis and the brachio-radialis. The pronator teres, from its insertion into the point of maximum lateral curvature of radius, can exercise its pronating action to great advantage. The balance of power is in favour of the supinators—as can be noted in all screwing actions—on account of the preponderating influence of the biceps.

Intercarpal Joints

In the carpus there are only two joint cavities. One is the cavity of the pisiform joint. The other is common to the rest of the intercarpal joints, for their cavities communicate reely with one another, and thus form one large, irregular, composite cavity.

At the **pisiform joint**, the pisiform bone articulates with the palmar surface of the triquetral bone, to which it is attached by an articular capsule.

The dissector has previously noted that the tendon of the flexor carpi ulnaris is inserted into the pisiform bone. To relieve the capsule from the strain to which this muscle subjects the joint, certain strong, accessory bands are provided which act virtually as secondary insertions of the muscle. They are the *piso-hamate* and the *piso-metacarpal ligaments* attached respectively to the hook of the hamate and the base of the fifth metacarpal bone.

The other **intercarpal joints** share one joint cavity (Fig. 93). The main part of the cavity of the joint is between the proximal and distal rows; but prolongations of it pass upwards between the three bones of the proximal row, and downwards between the four bones of the distal row; these downward prolongations communicate with the cavities of the carpo-metacarpal joints.

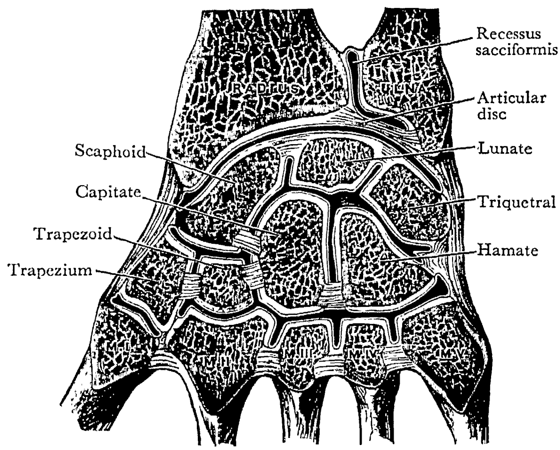

FIG. 93.—Coronal Section through Radio-Carpal, Intercarpal, and Carpo-Metacarpal and Intermetacarpal Joints to show Joint-Cavities and Interosseous Ligaments (diagrammatic).

Palmar and *dorsal intercarpal ligaments* pass between the corresponding surfaces of the bones of each row; and *interosseous ligaments* unite the non-articular parts of their contiguous surfaces. The interosseous ligaments of the proximal row have been seen already, for they complete the distal articular surface of the wrist joint; those of the distal row, less regular in position, will be seen when the transverse part of the intercarpal joint is opened.

The **transverse part** of the intercarpal joints lies between the proximal and distal rows of carpal bones. The two rows are bound together by a fibrous capsule which is attached to the palmar and dorsal surfaces and the medial and lateral ends of each row.

Articular Surfaces (Figs. 75, 93, 97).—The bones of the

proximal row articulate with one another by flat surfaces, and so do the bones of the distal row. In the transverse part of the intercarpal joint, the proximal parts of the capitate bone and the hamate bone form a high convexity which fits into a concavity formed by the distal surfaces of the triquetral and lunate bones and the distal part of the medial surface of the scaphoid bone; and the convex distal surface of the scaphoid bone is received into a concavity formed by the proximal surfaces of the trapezium and trapezoid bones. The two opposed surfaces of the transverse part of the joint are, therefore, concavo-convex from side to side and adapted one to the other. The synovial cavity may be partly interrupted by an interosseous ligament between the capitate and scaphoid bones (Fig. 93).

Movements at the Intercarpal Joints.—The movements at the intercarpal joints supplement those at the radio-carpal joint, and tend to increase the range of movement of the hand. Between the individual bones of each row the movement is of a gliding character, and very limited. At the transverse intercarpal joint, flexion and extension are the main movements, but some side to side gliding occurs between the rows to increase the range of adduction and abduction of the hand (p. 177).

By the multiplicity of joints in this part of the limb, strength and elasticity are contributed to the wrist.

Dissection.—**Remove the interosseous muscles from the metacarpal bones, and detach the flexor tendons from the fingers, but leave the extensor tendons in position. Define and clean the ligaments which connect the carpus and metacarpus, and those which unite the bases of the medial four metacarpal bones.**

Carpo-Metacarpal and Intermetacarpal Joints

The *metacarpal bone* of the *thumb* articulates with the os trapezium by a joint which is quite distinct from the other carpo-metacarpal joints. An articular capsule surrounds the joint, and is sufficiently lax to allow a very considerable range of movement.

The *medial four metacarpal bones* are connected to the carpus by *palmar* and *dorsal ligaments*, and by *one interosseous ligament*; and a *medial ligament* closes in the medial side of the joint of the fifth metacarpal bone.

The *interosseous ligament* springs from the contiguous distal margins of the capitate and hamate bones, and passes to the medial side of the base of the third metacarpal bone.

PLATE XXI

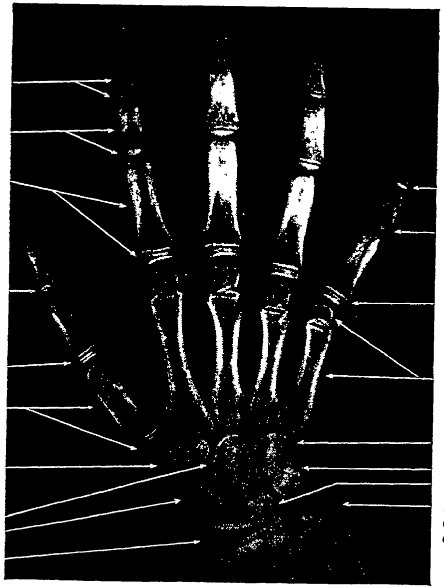

FIG. 94A.—Radiograph of Wrist and Hand of girl aged 7. Note the relative position of the ossifying carpal bones—the pisiform centre has not yet appeared.

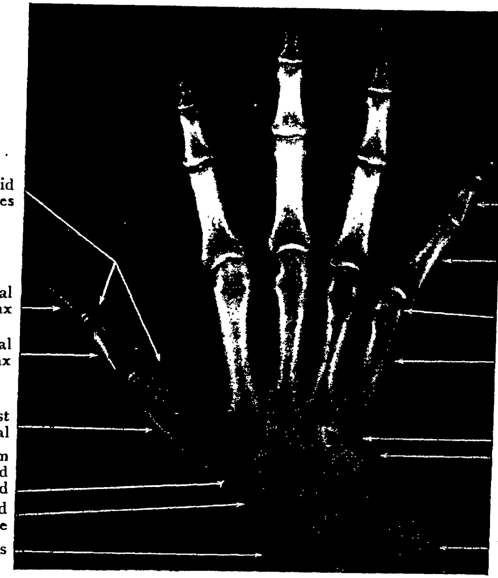

FIG. 94B.—Radiograph of Wrist and Hand of man aged 25. Compare with Fig. 94A for the identification and relative position of the carpal bones.

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PLATE XXII

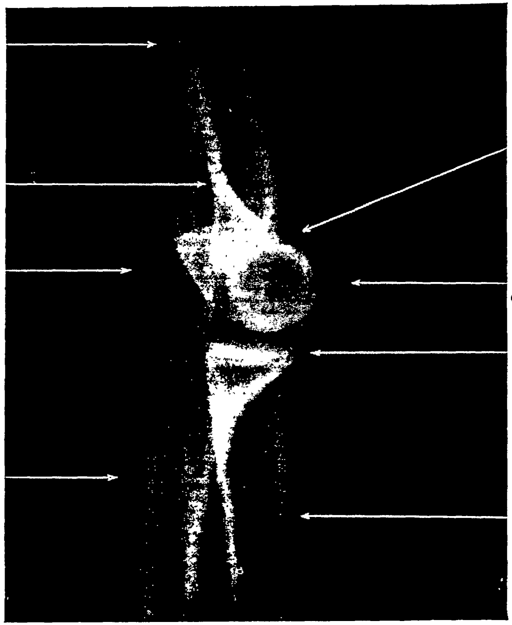


FIG. 95A.—Lateral Radiograph of same Elbow as in Fig. 82 fully extended. Note the tip of the olecranon in the olecranon fossa of the Humerus.

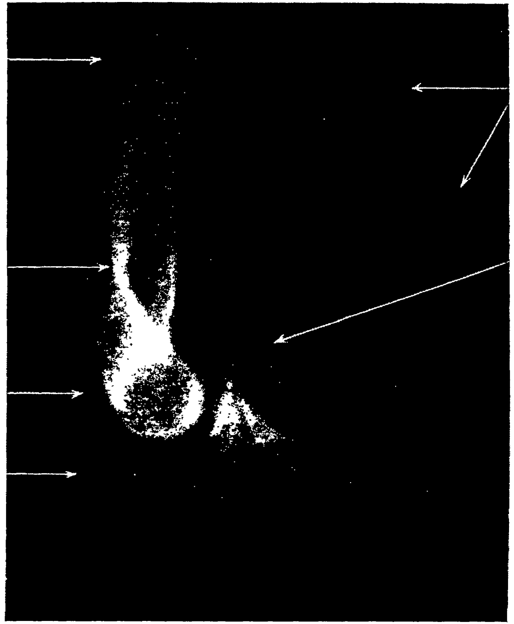


FIG. 95B.—Lateral Radiograph of same Elbow half-flexed. Note the relative position of epicondyle and olecranon.

[*Facing p.* 183

Dissection.—To display the interosseous ligament, divide the bands which connect the bases of the third and fourth metacarpal bones, and sever the dorsal ligaments which bind the medial two metacarpal bones to the carpus. The metacarpal bones thus set free can then be forcibly bent forwards, when the ligament in question will come into view.

The metacarpal bones of the fingers articulate with one another by their bases, and are united by strong ligaments. These are a series of transverse *palmar* and *dorsal ligaments*, and *three* stout *interosseous ligaments*, which pass between the non-articular parts of the sides of contiguous bases and will be seen later when the bases are separated.

In addition, the heads of the bones are indirectly connected by the *deep transverse metacarpal ligaments* (p. 167). These ligaments were cut in the dissection of the interosseous muscles.

Synovial Membranes of the Intercarpal, Carpo-Metacarpal, and Intermetacarpal Joints.—The pisiform joint and the carpo-metacarpal joint of the thumb both possess separate capsules ; but the various ligaments of the intercarpal, carpo-metacarpal and intermetacarpal joints, though they are spoken of individually as separate ligaments, constitute collectively a single capsule, which surrounds a continuous joint-cavity. The synovial membrane lines all the ligaments and is prolonged over all the intra-articular parts of the bones that are not covered with articular cartilage.

Dissection.—To display the articular surfaces of the carpo-metacarpal joints, detach the metacarpus from the carpus. To see the interosseous ligaments, separate the bones of the second row of the carpus from one another, and deal similarly with the bases of the metacarpal bones.

Articular Surfaces.—The base of the metacarpal bone of the index will be seen to be hollowed out for the reception of the trapezoid bone. It articulates also with the trapezium on the lateral side, and with the capitate bone on the medial side. The base of the third metacarpal rests against the capitate bone alone. The base of the fourth metacarpal bone rests upon the hamate bone, but articulates slightly with the capitate bone also. The fifth metacarpal bone articulates with the hamate bone (Figs. 62, 75, 77, 94 A and B).

The *nerve-supply* of the intercarpal, carpo-metacarpal and intermetacarpal joints is derived from the anterior and post-

erior interosseous nerves, and the dorsal and deep branches of the ulnar nerve.

Movements of the Metacarpal Bones.—The opposed surfaces of the os trapezium and the metacarpal bone of the thumb, being saddle-shaped, allow free movement at that joint. Thus, the metacarpal bone of the thumb can be moved :—(1) dorso-laterally (extension) ; (2) forwards and medially (flexion) ; (3) medially towards the index (adduction) ; (4) laterally (abduction). A combination of the above-mentioned movements, occurring one after the other, constitutes circumduction ; but a more important combination is that of flexion with *opposition*, whereby the thumb is carried medially across the palm and can be brought into contact with any of the fingers. The student should consider the actions of the various muscles attached to the thumb in relation to these movements.

The metacarpal bones of the index and middle fingers possess very little power of independent movement. The metacarpal bone of the ring-finger, and more especially the metacarpal bone of the little finger, are not so tightly bound to the carpus : when the hand is clenched they both move forwards. The metacarpal bone of the little finger is provided with an opponens muscle, which has the power of moving the bone forwards and laterally towards the thumb, and thus assists in the " cupping of the hand ".

Metacarpo-Phalangeal and Interphalangeal Joints

The ligaments of a metacarpo-phalangeal joint and an interphalangeal joint are alike.

Articular Capsules.—In each joint there is a fibrous capsule, thickened in front to form a *palmar ligament*, and thickened at the sides to form *collateral ligaments*. On the dorsum of the joint, the fibrous capsule is exceedingly thin, for it is fused with the overlying extensor tendon ; and the protection thus afforded by the tendon makes a thick fibrous covering of the synovial membrane unnecessary.

Collateral Ligaments.—The collateral ligaments are strong oblique bands that pass downwards and forwards from the sides of the head of the proximal bone of the joint to the sides of the base of the distal bone (Fig. 67, p. 145).

Palmar Ligament.—This is a strong, thick, fibrous plate. It is attached loosely to the neck of the proximal bone, extends over the palmar surface of the head, and is attached firmly to the base of the distal bone. It forms part of the socket for the head of the proximal bone, whose palmar surface articulates with it when the joint is straight. The margins of each palmar ligament are continuous with the collateral ligaments, and give attachment to the margins of the fibrous

flexor sheath ; and its palmar surface is covered by the flexor tendon and the synovial sheath.

In a metacarpo-phalangeal joint of a finger, the margins of the palmar ligament give attachment also to the deep transverse metacarpal ligament and partial attachment to the processes of the palmar aponeurosis.

The *nerve-supply* of the metacarpo-phalangeal joints and of the interphalangeal joints is derived from the nerves that innervate the skin of the digits to which they belong.

Sesamoid Bones.—In the metacarpo-phalangeal joint of the thumb, the palmar ligament is fused with the tendons of the adductor pollicis and flexor pollicis brevis. In the fused ligament and tendons, two little *sesamoid bones* are developed which articulate with the palmar surface of the head of the first metacarpal bone. Sometimes minute sesamoid bones are found in the palmar ligaments of other metacarpo-phalangeal joints, the joints of the index and the little finger being the most frequent (Figs. 75, 94B).

Dissection.—**Raise the extensor tendons from the metacarpo-phalangeal joints. If this is done carefully, the dorsal part of each capsule (which is very thin) will be left intact.**

Movements at the Metacarpo-Phalangeal Joints.—In each metacarpo-phalangeal joint, the concave surface of the phalanx receives the convex surface of the head of the metacarpal bone. The joints are condyloid ; the movements are therefore : (1) flexion, (2) extension, (3) abduction, (4) adduction, (5) circumduction. There is no provision for active or voluntary rotatory movements at these joints ; but, if a finger is seized by the other hand and twisted, it will be seen that considerable passive rotatory movement is possible.

During flexion of the fingers, the proximal phalanx and the palmar ligament travel forwards upon the head of the metacarpal bone ; and the collateral ligaments, owing to the fact that they are attached nearer to the distal surface than to the palmar surface of the head, tighten so that lateral movement is restricted. The *interosseous* and *lumbrical* muscles are chiefly instrumental in producing this movement, but they are aided by the long and short flexors of the digits.

The proximal phalanges of the fingers, in the movement of extension, can be carried backwards only to a very slight degree beyond the line of the metacarpal bones. The *extensor digitorum* and the *extensores indicis* and *digiti minimi* are the muscles which operate in this movement.

Abduction and adduction are movements of the proximal phalanx away from and towards a line prolonged distally through the middle finger, and are seen when the fingers are spread out and drawn together again. The action of the interosseous muscles in these movements is explained on pp. 169-170. It should be noticed that the movements of abduction and adduction are very free in the extended position of the fingers ; but, if flexion is induced, the power of separating the fingers becomes more and more restricted, until it becomes lost when the hand is closed. This

is due only partly to the arrangement of the collateral ligaments mentioned above, and perhaps mainly to the restricting action of the flexors (see p. 160).

Very little abduction or adduction is possible at the metacarpo-phalangeal joint of the thumb. These movements take place at its carpo-metacarpal joint.

Movements at the Interphalangeal Joints.—The interphalangeal joints are hinge joints; therefore the only movements possible are flexion and extension. Flexion of the middle phalanges of the fingers is brought about by the flexor sublimis, and of the distal phalanges by the flexor profundus. Extension of the phalanges at the interphalangeal joints is produced not only by the extensors of the digits but also by the interosseous and lumbrical muscles acting through the extensor expansions, into which they are inserted; it is probable that extension of the middle and distal phalanges is brought about chiefly by the interossei and the lumbricals. The interossei and lumbricals, therefore, flex the proximal phalanges at the metacarpo-phalangeal joints and extend the middle and distal phalanges at the interphalangeal joints.

In the thumb, the flexor pollicis longus and the extensor pollicis longus operate at the interphalangeal joint.

PLATE XXIII

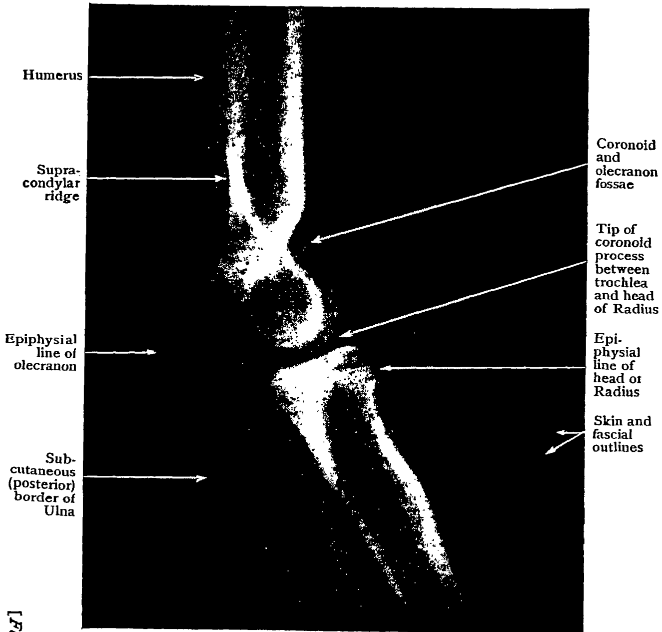


FIG. 96.—Lateral Radiograph of slightly flexed Elbow of girl aged 12. Note the uniting epiphyses of head of Radius and olecranon of Ulna.

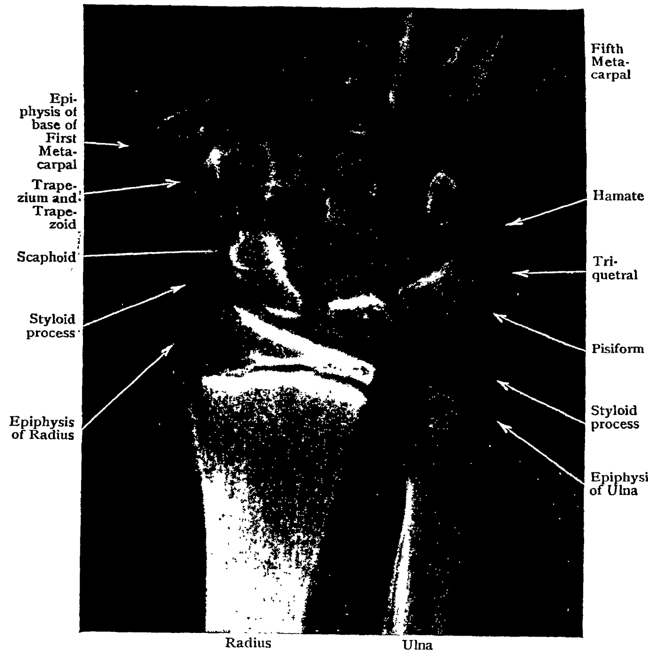


FIG. 97.—Radiograph of Wrist of girl aged 14, to show the distal epiphyses of Radius and Ulna.

PLATE XXIV

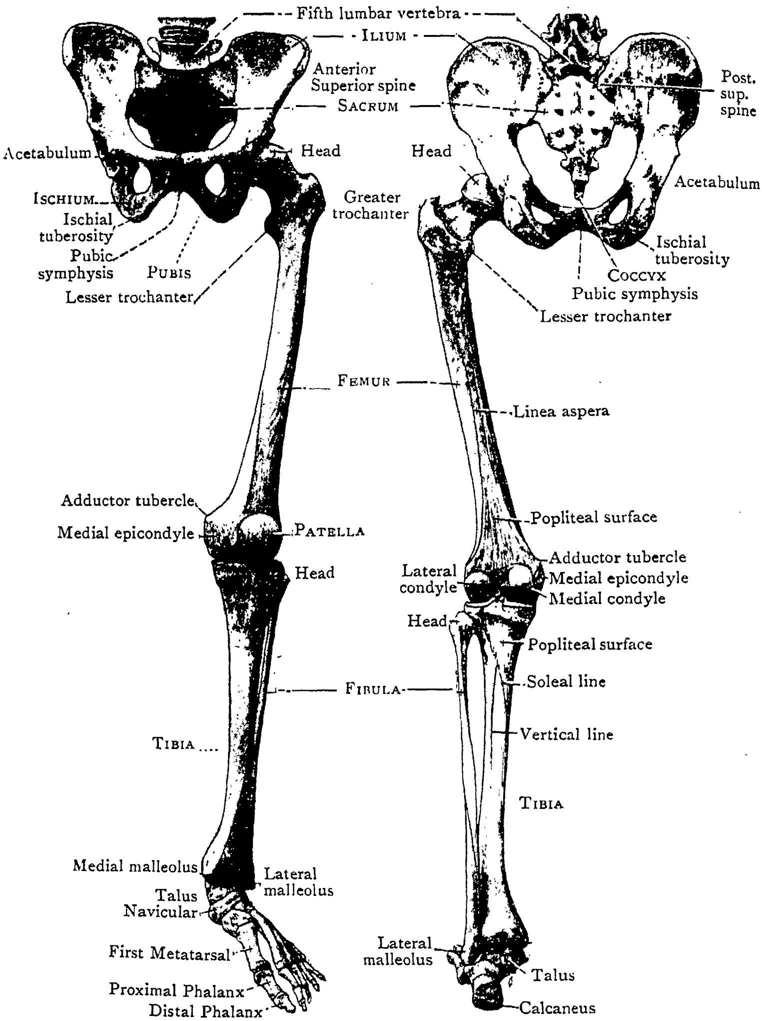


FIG. 98.—Bones of Left Lower Limb.

Anterior view. Posterior view.

LOWER LIMB[1]

Introduction.—The parts of the lower limb are the *hip* and *buttock*, the *thigh*, the *leg*, and the *foot* and *toes*.

The hip and buttock make up what is called the **gluteal region**, which overlies the side and the back of the pelvis, extending from the waist and the small of the back down to the hollow on the side of the hip and to the fold or groove that limits the buttock below. The hip and the buttock are not sharply distinguished from each other either in anatomical descriptions or in ordinary English usage; but the **hip** (coxa) may be taken as the upper part of the region and the part presented in a side view, while the **buttock** (natis) is the rounded bulging behind and below. The groove that limits the buttock inferiorly is called the **gluteal fold**. The cleft between the buttocks is called the **natal cleft** (Fig. 115, p. 228); its lower part—*i.e.*, the part beyond the end of the backbone—is included in the perineum.

The skeleton of the hip and buttock is one bone called the **hip-bone**; but it is made up of three parts united at the *acetabulum* where the femur articulates with it (Fig. 93). The **ilium** is the large, upper part, and is felt in the lower margin of the waist. The **ischium** is the lower and hinder part, on which the body rests in the sitting posture. The **pubis** is the anterior part, and is the bone felt at the lower part of the front of the abdomen.

The hip-bone forms part of the skeleton of the trunk also. The right and left hip-bones, together with the sacrum and the coccyx, make up the skeleton of the pelvis; and the hip-bone is sometimes called the *pelvic girdle*. At the front, the two hip-bones articulate with each other to form a joint called the **pubic symphysis** (*symphysis* = union). At the back, they articulate with the sides of the sacrum at the **sacro-iliac joints**.

The **thigh** (femur) extends from the hip to the knee

[1] If the first part allotted to the student is the Lower Limb, he will read the general introductory paragraphs on pp. 1-19 before he begins its dissection.

in the second row. They are placed side by side—the **cuboid bone** most laterally, and then three bones called **cuneiform bones** because they are wedge-shaped (*cuneus* = a wedge). The bone between the rows is called the **navicular bone**; it separates the cuneiform bones from the talus. The tarsal bones articulate with one another forming **intertarsal joints.**

The **metatarsus** has a skeleton of five **metatarsal bones.** They are set side by side behind the toes, and are numbered 1 to 5—beginning with the one behind the big toe. Their posterior ends are called their *bases*; their anterior ends are called their *heads*. The bases articulate with one another forming **intermetatarsal joints,** and with the cuboid and cuneiform bones forming **tarso-metatarsal joints.**

The **toes** or digits are numbered from medial to lateral side; but the first toe is called also the big toe or *hallux*, and the fifth is the little toe (*digitus minimus*). The bones of the toes are called **phalanges.** The big toe has two phalanges—a proximal phalanx and a distal. Each of the other toes has three—proximal, middle and distal. Each proximal phalanx articulates with the head of a metatarsal bone to form a **metatarso-phalangeal joint.** The middle phalanx articulates with the other two to form **interphalangeal joints.** The proximal end of a phalanx is called its *base* and its distal end is its *head.*

Bones that are embedded in the substance of tendons are called **sesamoid bones.** The largest is the *patella.* The others are very small, and some of them are often absent; the two that are always present lie on the plantar surface of the first metatarso-phalangeal joint (Fig. 191, p. 370).

FRONT OF THIGH

The order of dissection of the Lower Limb depends upon the arrangement that has been made for the general allotment of parts. If, according to a common plan, the limb is to be dissected in continuity with the Pelvis by the same dissectors, it may be advisable to begin with the gluteal region (p. 227) and to dissect the greater part of the thigh before any special dissection of the pelvis from the side is undertaken (see Vol. II, p. 404). If, however, the limb be allotted separately, the dissection begins at the same time as the dis-

section of the anterior abdominal wall with the body lying on its back ; the pelvis should be supported by blocks, and the lower limbs stretched out at full length. During the five days that the body remains in this position the dissector has a very extensive dissection to perform. He has to dissect—(1) the front of the thigh, including the *femoral triangle* and its contents, (2) a portion, at least, of the medial side of the thigh, including the *adductor canal* and its contents.

With so much work to be completed within a limited time, it should be regulated day by day as follows. During the **first day** study the surface anatomy and dissect the superficial structures of the whole of the front and medial side of the thigh. The **second** and **third** days should see the dissection of the *femoral triangle* and the *adductor canal* completed. The **fourth** and **fifth** days should be devoted to the remainder of the dissection and to revision.

Before making the preliminary incisions in the skin, the dissector must study the surface-anatomy of the region.

Surface-Anatomy.—The **pubic symphysis** (p. 187, Fig. 98) is in the median plane, at the lowest part of the front of the abdomen, between the right and left pubic bones. Below and behind the symphysis, there is a wide archway, called the **pubic arch,** whose sides are formed by the right and left pubis and ischium. Find the lower part of the symphysis, and press your fingers along one side of the arch. It is at the uppermost part of the medial side of the thigh, in the boundary between the thigh and the perineum. Next, find the upper margin of the symphysis, and draw your finger in a lateral direction. The bone felt is the **pubic crest.** The crest is about one inch long, and ends laterally in the **pubic tubercle,** a small, blunt prominence at that distance from the symphysis.

Find the **iliac crest,** which is the bone felt in the lower margin of the waist. Trace it forwards, and note that it curves slightly in a medial direction, and slopes markedly downwards. Its anterior end is called the **anterior superior iliac spine,** and in a thin body it can be gripped between finger and thumb. Between this spine and the pubic tubercle, there is a shallow, curved groove that separates the front of the thigh from the front of the abdomen. Press your finger along the groove, and feel a resisting, elastic band: that is the **inguinal ligament,** which stretches between the spine and

the tubercle. Run your finger upwards and backwards from the spine along the outer edge or lip of the iliac crest, until you feel a low prominence called the **tubercle of the iliac crest**; it is at the widest part of the pelvis, and is therefore the highest point of the crest seen from the front, though the actual highest point is farther round at the back. A hand's breadth below the tubercle, the **greater trochanter** of the femur is near the surface, and forms a wide prominence just in front of the hollow on the side of the hip; the top of the trochanter is about the same level as the pubic crest.

The **head of the femur**, which articulates with the hip bone, is deeply hidden under muscles; but it can be felt. Place your finger on a spot, just below the inguinal groove, midway between the anterior superior iliac spine and the pubic symphysis; press firmly and rotate the limb this way and that; the head of the femur should be felt moving beneath muscle. In the living limb, the pulsations of the *femoral artery* are felt at the same spot.

The **shaft of the femur** is thickly covered with muscles throughout its length.

At the knee, the **patella** is a familiar object. The **ligamentum patellæ** stretches downwards from it and leads you to the **tuberosity of the tibia**, which is a blunt prominence on the front of the upper end of the tibia. It is a very strong tendon—two inches long and one inch wide—that can be gripped between finger and thumb, and is felt best when the knee is half bent. Grasp the patella and try to move it. It is movable when the knee is straight, but not when the knee is bent—for then the ligamentum patellæ is put upon the stretch. When the knee is bent, the patella is drawn off the front of the femur on to its lower end; and the **patellar surface** of the femur can be felt (if you press firmly) through the muscles above the patella (Figs. 171, 172 A and B).

The large masses of bone at the sides of the knee are the **lateral** and **medial condyles** of the femur and of the tibia. With the knee bent, feel the sides of the femoral condyles; their most prominent points are called the **lateral** and **medial epicondyles** of the femur, and are nearer the back of the knee than the front.

Straighten the knee, and look at the posterior part of its medial surface. Note a low, longitudinal fleshy elevation about the width of a finger. It is the lower part of the

sartorius muscle, which runs downwards from the anterior superior iliac spine obliquely across the thigh and can be

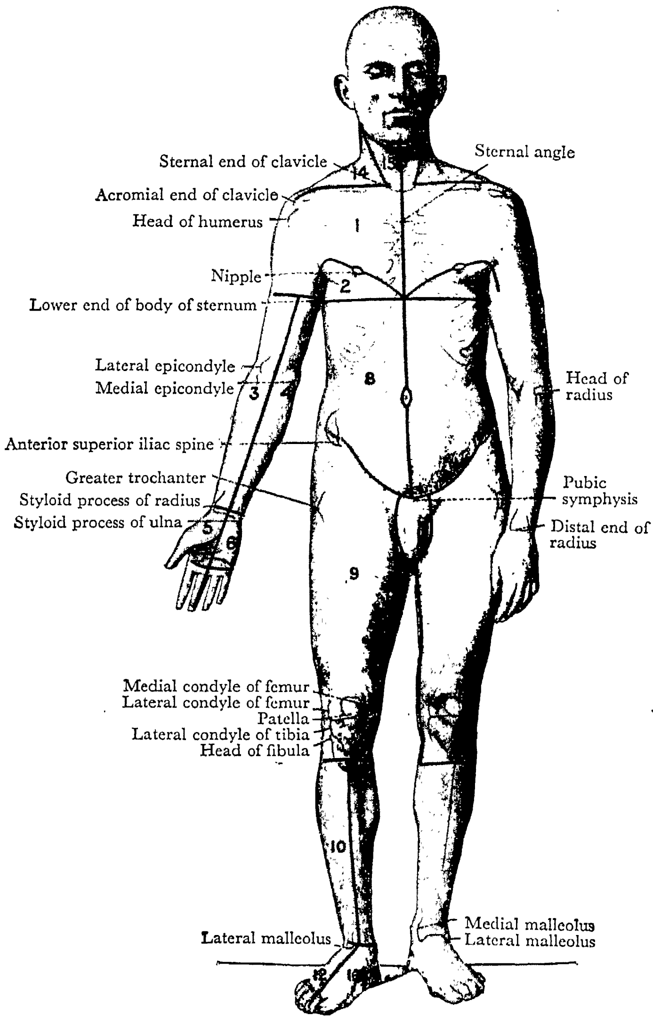


FIG. 99.—Landmarks and Incisions. For the bony landmarks, cf. Fig. 98, Pl. XXIV.

brought into prominence in the living limb by bending it at both knee and hip joints and rotating the thigh outwards (p. 215). Bend the knee, and note that the muscle slips backwards off the medial condyle of the femur into the medial boundary of the popliteal fossa.

The wide, smooth fleshy swelling above the medial condyle is the lower part of a large muscle called the **vastus medialis.** When the knee is bent, that swelling is limited posteriorly by a wide, shallow groove. Press your finger into that groove; a tense band is felt in its floor; that is the tendon of a large muscle called the **adductor magnus.** Draw the finger downwards; it will be caught on a small prominence of bone, called the **adductor tubercle,** which projects from the uppermost part of the medial condyle (Fig. 98).

SUPERFICIAL DISSECTION

General instructions for making incisions and for the removal of skin and superficial fascia are given on p. 15.

Dissection.—Reflexion of the Skin—*Incisions* (Fig. 99).—(1) From the anterior superior iliac spine along the line of the inguinal ligament to the pubic symphysis; (2) from the symphysis downwards along the medial side of the thigh and knee to the level of the tubercle of the tibia; (3) from the lower end of the vertical incision transversely across the front of the leg to its lateral border.

Raise the quadrilateral flap of skin, thus mapped out (9. Fig. 99), carefully from the superficial fascia and turn it laterally, taking particular care in the region of the knee to avoid injury to the patellar plexus of cutaneous nerves.

Superficial Fascia.—In the region now exposed the fat of the superficial fascia is usually abundant, especially on the medial side of the thigh. The deeper part of the superficial fascia is membranous throughout the region; but its membranous character is most manifest in the uppermost part of the region. There, it forms a distinct layer, to some extent separated from the fatty layer by vessels and lymph-nodes (Fig. 100); and the two layers can be separated by a little dissection. Both layers of the superficial fascia are continuous with the corresponding layers on the anterior wall of the abdomen. The membranous layer is loosely attached to the deep fascia of the thigh by areolar tissue except near the inguinal ligament, where there is a linear, fairly firm

attachment. The line of firm connexion or fusion begins a little lateral to the pubic tubercle and extends nearly horizontally in a lateral direction for about three inches. The medial part of the line may coincide with the medial part of the inguinal ligament or may be a little below it; but, as the lateral part of the ligament is very oblique, the lateral part of the line is farther and farther away from it.

This connexion is of some practical importance, and, to demonstrate it, the dissectors of the Lower Limb and the Abdomen must work together.

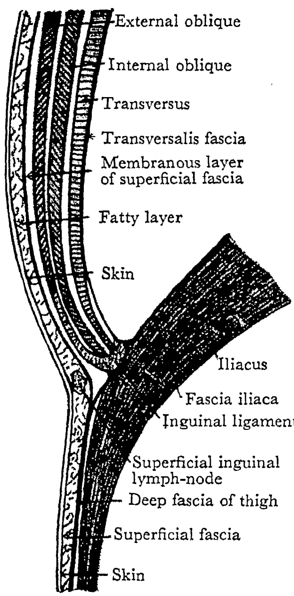


FIG. 100.—Diagram of Fasciæ and Muscles of Inguinal and Subinguinal Regions lateral to Saphenous Opening. Cf. Fig. 108.

Dissection. — Make a transverse incision through the entire thickness of the superficial fascia on the front of the abdomen from the anterior superior iliac spine to the median line of the body. When the lower edge of the divided fascia is raised, its two layers are easily distinguished. Insinuate the fingers between the membranous layer and the aponeurosis of the external oblique muscle of the abdomen. Little resistance will be encountered, for the fascia and the aponeurosis are connected only by some fragile areolar tissue, and the fingers can be passed downwards as far as the union of the membranous layer with the deep fascia of the thigh. If the fingers are now carried medially along the line of union, it will be found that the line of attachment descends across the front of the pubis into the perineum, where its connexions may have been examined already by the dissector of the Abdomen.

If urine is effused into the anterior part of the male perineum from a rupture of the urethra, it cannot pass into the medial side of the thigh because of the attachment of the membranous layer of the superficial fascia to the side of the pubic arch and to the front of the pubis, but it can ascend

between the membranous layer and the deep fascia to the wall of the abdomen. Having reached the wall of the abdomen, it cannot descend into the front of the thigh because of the connexion between the membranous layer and the deep fascia of the thigh (see Vol. II, pp. 139, 379).

The dissector will now proceed to display the structures that lie in the superficial fascia and under cover of it.

Dissection.—Begin with the *great saphenous vein.* It is easily found about the mid-length of the thigh, near the medial border. Follow it downwards to the medial side of the knee, and upwards to its termination in the femoral vein. Some *lymph-nodes* of fairly large size lie along the sides of the upper part of the vein. Clean them, and note the delicate, thread-like lymph-vessels connected with them. Lift the upper end of the vein from its bed, and note that, to reach the femoral vein, it bends backwards over a fairly sharp edge of deep fascia.

The edge of fascia now exposed is the lower margin of the *saphenous opening*, an oval gap in the deep fascia, situated just below the medial part of the inguinal ligament. The opening will be exposed later.

Dissection.—Clean the small superficial blood-vessels of the groin. Follow the arteries and veins together as they radiate from the region of the saphenous opening—the *superficial circumflex iliac* laterally, the *superficial epigastric* upwards, and the *superficial external pudendal* medially. Define and retain in position the lymph-nodes that are met with. As the external pudendal artery is traced medially, note that its branches pass superficial to the spermatic cord (Fig. 101).

The *spermatic cord* is a thick, soft bundle—almost as thick as a little finger—that emerges from the abdomen just above the medial end of the inguinal ligament; it appears through an opening called the *superficial inguinal ring* and descends into the scrotum. It will be cleaned by the dissector of the Abdomen, but the dissector of the Lower Limb will note that it crosses a corner of his territory. If the subject is a female, the spermatic cord is replaced by a slender, inconspicuous band, called the *round ligament of the uterus*, that emerges through the same point in the abdominal wall and descends into the labium majus.

Dissection.—Identify the *ilio-inguinal nerve* (Fig. 104). It is a slender nerve that leaves the abdomen through the lateral part of the superficial inguinal ring, and is distributed mainly to the external genital organs Trace the branches of the nerve that pass to the thigh.

Clean the lymph-nodes that lie along the lower border of the inguinal ligament. They vary in size.

Next, complete the exposure of the *saphenous opening* by defining its lateral and upper margins. Clear away the *cribriform fascia*, a thin layer that closes the opening, but do so carefully—disentangling the vessels that pierce it, and avoiding injury to the structures behind it. Observe that it is attached medially to the surface of the deep fascia, and that the saphenous opening has no definite medial margin.

The removal of the cribriform fascia exposes the greater part of the anterior wall of the *femoral sheath*—that is, the fascial layer that surrounds the uppermost inch and a half of the femoral artery and vein. The sheath is very liable to be injured as the cribriform fascia is removed. If that has happened, the femoral vessels will be partly exposed. Note that the vein is opposite the opening, while the artery is behind its lateral margin.

Dissection.—Look for the remaining cutaneous nerves, seeking them first, with the help of Figs. 101 and 104, at the points where they pierce the deep fascia and trace them downwards. They are named and described on pp. 199-202.

The *saphenous nerve*, the principal distribution of which is in the leg and foot, becomes superficial much lower than the others; it appears behind the vein at the medial side of the knee; and its *infrapatellar* branch appears in front of the vein above the knee.

Look for a network of slender nerves in front of the patella. It is called the *patellar plexus*, and is formed by branches of several cutaneous nerves. At the same time, see if there is any evidence of a subcutaneous *bursa* in front of the patella.

Superficial Inguinal Vessels.—Three small arteries—the *superficial external pudendal*, the *superficial epigastric*, and the *superficial circumflex iliac*—pierce the cribriform fascia or the deep fascia of the thigh below the inguinal ligament, and radiate from their origin in the directions that their names imply. They supply the skin of the external genital organs, of the groin and of the lower part of the anterior abdominal wall, and the inguinal lymph-nodes (Fig. 101). They all spring from the femoral artery immediately after it enters the thigh.

The *veins* which accompany these arteries converge towards the saphenous opening and join the *great saphenous vein* before it pierces the cribriform fascia.

Lymph-Nodes and Lymph-Vessels.—The superficial inguinal lymph-nodes are arranged in two main groups:—(1) An *upper* group of large nodes spread out immediately

below the line where the membranous layer of superficial ascia is fused with the deep fascia of the thigh; one or two small outlying members of this group may be found above the inguinal ligament on the course of the superficial epi-

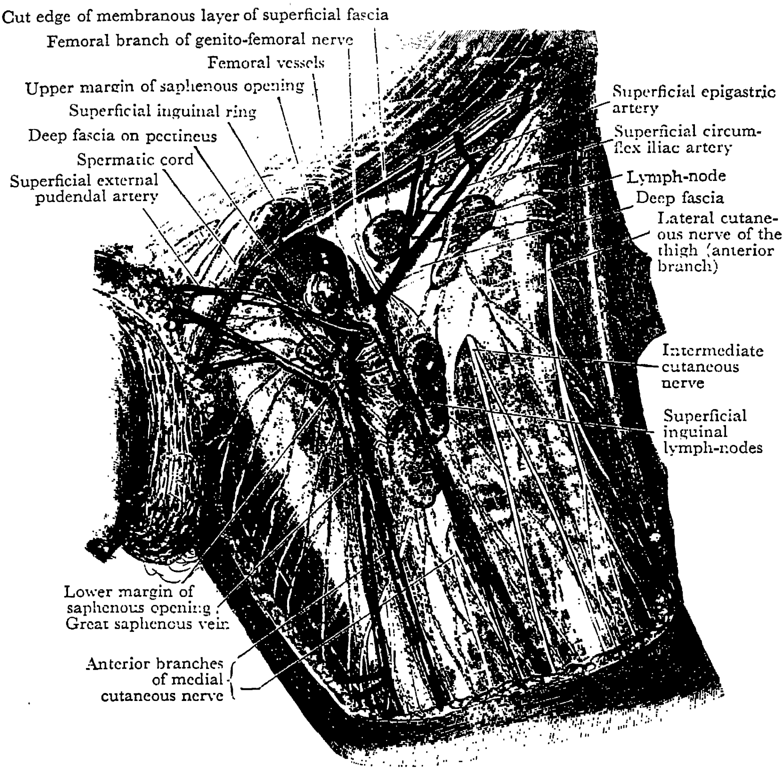


FIG. 101.—Superficial Dissection of proximal part of Front of Thigh. The Saphenous Opening, and the superficial Lymph-Nodes and Lymph-Vessels of the groin are displayed. The lymph-vessels may be recognised by their beaded appearance.

gastric vessels. (2) A *lower* group made up of a variable number of large nodes placed along both sides of the upper part of the great saphenous vein (Figs. 101, 153).

In a spare subject, or, better still, in a dropsical subject, the general arrangement of the lymph-vessels may also be made

out. These groups of lymph-nodes receive the superficial vessels of (1) the lower limb, including the gluteal region, (2) the external genital organs, (3) the perineum, and (4) the lower part of the anterior wall of the abdomen. They receive also some of the lymph-vessels from certain organs in the pelvis. Swollen, painful nodes in the groin may therefore signify disease in the superficial parts named above, or they may be a sign of disease in a pelvic organ. Numerous vessels connect the nodes with one another. The efferent vessels pass through the cribriform fascia and the deep fascia around the saphenous opening, and end in the deep inguinal nodes (which lie alongside the upper part of the femoral vessels) and in the external iliac nodes (which lie in the abdomen around the external iliac artery and are described in Vol. II.).

Saphenous Opening.—The saphenous opening is an oval aperture in the deep fascia of the thigh. Its position and dimensions should be carefully noted, because through it a femoral hernia makes its way towards the surface (see p. 210). It is about an inch and a half long and half an inch wide. It is situated just below the inguinal ligament, and its centre is about an inch and a half below and lateral to the pubic tubercle. Spread over the opening, there is a thin portion of the deep fascia called the **cribriform fascia** because it is perforated by certain vessels (*Cribrum* = a sieve). These vessels are the great saphenous vein, one or more of the superficial arteries, and some of the lymph-vessels that connect the superficial and deep inguinal lymph-nodes.

The femoral vessels, enclosed in a fascial sheath, are immediately behind the opening; the whole width of the vein is exposed in the opening, but the artery is overlapped by the lateral margin.

The upper, lower and lateral margins of the opening form one crescentic, sharp edge of deep fascia called the **falciform margin** of the saphenous opening. The lower margin is better defined than the upper because the great saphenous vein hooks backwards over it to join the femoral vein. On the medial side the deep fascia that covers the pectineus muscle —the *pectineal fascia*—slopes in a lateral direction and backwards, and disappears behind the femoral sheath (Figs. 107, 110); the medial margin of the opening is therefore an oblique surface instead of a sharp edge.

Great Saphenous Vein.—This is the largest superficial vein of the lower limb. In the thigh, it is frequently concealed in the fat, but in the leg it is usually very evident in the living limb—and hence the name (*saphes* = easily seen). In the condition known as "varicose veins", it is often very conspicuous and tortuous. It begins on the medial side of the dorsum of the foot, passes upwards in front of the medial malleolus, and ascends through the leg across the medial surface of the distal third of the tibia, and then along the medial margin of the tibia. It enters the area under dissection far back on the medial side of the knee, continues its ascent with a lateral and forward inclination, and passes to the saphenous opening, where, hooking backwards over its lower margin, it pierces the cribriform fascia and the femoral sheath to end in the femoral vein.

During its ascent, it communicates, through the deep fascia, with the deep veins; and it receives numerous tributaries, including the superficial veins of the groin which join it near its termination.

There are several valves in its interior which help to divide the column of blood into sections, and so reduce the pressure on the walls of the distal part of the vein.

Superficial Inguinal Ring.—This is the aperture in the aponeurosis of the external oblique muscle of the abdominal wall through which the spermatic cord (or the round ligment of the uterus) escapes from the abdomen. It has probably been displayed by the dissector of the Abdomen already, and will be studied by him; but the dissector of the Lower Limb will note its position: it is immediately above the pubic tubercle and the medial end of the inguinal ligament.

Cutaneous Nerves.—Six cutaneous nerves are met with in the area of the present dissection; three come directly from the lumbar plexus of nerves in the abdomen; and three come from the femoral nerve, which springs from the lumbar plexus (Figs. 102, 104). They communicate with one another, and the areas of skin supplied by them overlap.

From the lumbar plexus,	Ilio-inguinal nerve. Femoral branch of the genito-femoral nerve. Lateral cutaneous nerve of thigh.
From the femoral nerve,	Intermediate cutaneous nerve of thigh. Medial cutaneous nerve of thigh. Saphenous nerve.

The **ilio-inguinal nerve** (L. 1) escapes through the lateral part of the superficial inguinal ring. Most of its branches go to the scrotum or to the labium majus, according to the sex; but some are distributed to the skin of the adjacent part of the thigh.

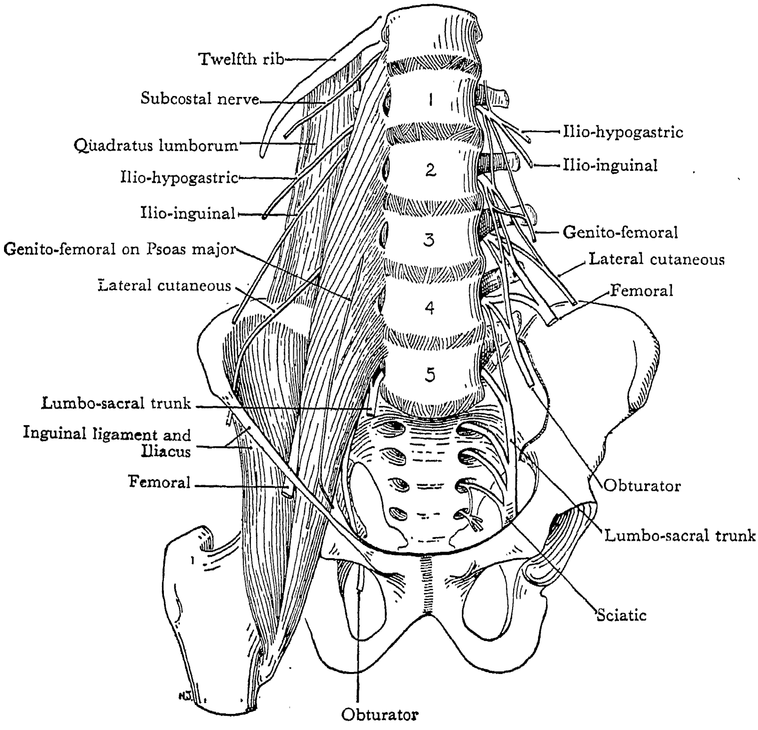


FIG. 102.—Lumbar Plexus (semi-diagrammatic), in relation to Quadratus Lumborum and Ilio-Psoas muscles.

The **femoral branch of the genito-femoral nerve** (L. 1, 2) is a slender nerve, not easily found, that pierces the deep fascia about an inch below the inguinal ligament, a little lateral to the saphenous opening. It supplies an area of skin, about the size of the palm of the hand, immediately below the inguinal ligament.

The **lateral cutaneous nerve of the thigh** (L. 2, 3) escapes from the abdomen close to the anterior superior iliac spine,

behind the inguinal ligament, and descends over the surface of the sartorius muscle, embedded in a thick ridge of deep fascia which must be slit up to expose the nerve. Two inches below the anterior superior spine, the nerve divides into two branches—an anterior and a posterior. The *posterior branch*

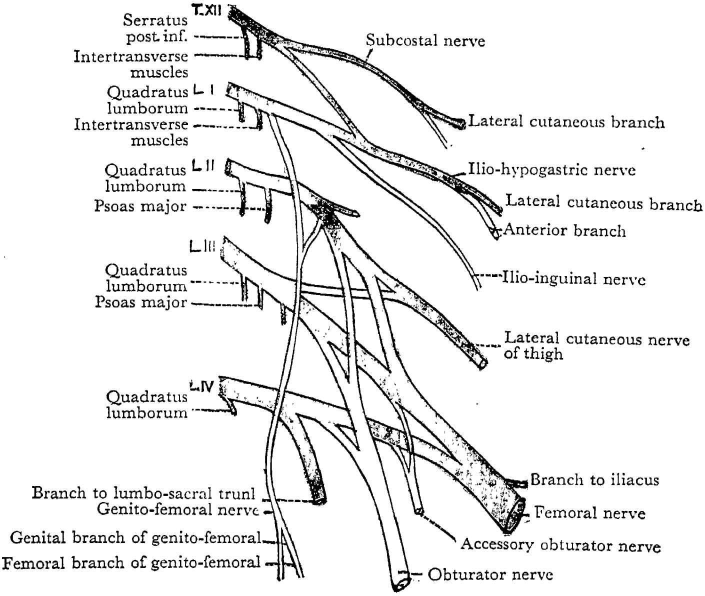


FIG. 103.—Diagram of Lumbar Plexus.

Ventral offsets, yellow; dorsal offsets, green. For the principle of the formation and distribution of the plexus, see p. 49, and cf. the arrangement of the brachial plexus, Fig. 18, p. 48. For the sacral part of the lumbo-sacral plexus, see Fig. 119, p. 240.

pierces the deep fascia at once, and runs backwards and downwards to supply the skin over the greater trochanter and the adjoining part of the gluteal region and thigh. The *anterior branch* is longer. It pierces the deep fascia two inches lower down, and descends to the lateral side of the patella, giving branches to the skin of the lateral side and front of the thigh.

The **intermediate cutaneous nerve of the thigh** (L. 2, 3) pierces the deep fascia in the middle line of the thigh about the junction of its upper and middle thirds. It

appears usually as two branches which perforate the fascia near each other. Both branches extend to the knee.

FIG. 104.—Cutaneous Nerves on Front of Lower Limb. See also Fig. 116, p. 229.

The **medial cutaneous nerve of the thigh** (L. 2, 3) also divides into two portions—an anterior and a posterior—which perforate the deep fascia on the medial side of the thigh at some distance from each other. The *anterior branch* emerges at the junction of the lower and middle thirds of the thigh, in front of the great saphenous vein; it descends to the knee, and its terminal branches turn forwards to reach the front of the patella. The *posterior branch* reaches the surface near the knee, behind the great saphenous vein, and descends to supply the skin on the medial side of the upper part of the leg. But the main stem of the medial cutaneous nerve sends a few twigs also to the skin of the middle third of the medial side of the thigh. These make their appearance along the line of the great saphenous vein.

The **saphenous nerve** (L. 3, 4) becomes subcutaneous on the medial side of the knee by perforating the fascia between the sartorius and the tendon of the gracilis muscle, and passes into the leg in front of the great saphenous vein. A small artery

—the *saphenous branch* of the *descending genicular artery*—is a useful guide to it as it runs downwards along the nerve. Before the saphenous nerve pierces the fascia it gives off an infrapatellar branch.

The *infrapatellar branch* pierces the sartorius muscle and the deep fascia on the medial side of the knee, and curves downwards and forwards to reach the front of the joint, below the patella (Fig. 104).

Patellar Plexus.—Filaments of four nerves have been traced to the skin of the knee, viz., the saphenous, the intermediate cutaneous, and the anterior divisions of the lateral and medial cutaneous nerves of the thigh. These filaments communicate with one another and form an interlacement, termed the *patellar plexus*, which is situated over the patella, ligamentum patellæ, and proximal part of the tibia.

Dissection.**—Remove the remains of the superficial fascia, in order to expose the deep fascia, but leave the cutaneous nerves and vessels. On the medial side of the thigh, the deep fascia is very thin, and you must take care not to remove it with the superficial fascia. On the front of the knee, look again for evidence of a prepatellar synovial bursa.**

Fascia Lata.—The **deep fascia of the thigh** is called the fascia lata. Only a portion of it is displayed at present, but the dissector should obtain a general idea of its attachments and parts before proceeding farther with the dissection. One of its striking features is the marked difference in strength which it shows on the lateral and the medial sides of the thigh.

On the medial side the fascia lata is so delicate and thin that the subjacent muscular fibres shine through it. *On the lateral side* it is very dense and is thickened to form a long, strong, wide band called the **ilio-tibial tract**, which stretches from the iliac crest to the lateral condyle of the tibia.

Around the root of the limb, the fascia lata is attached to the inguinal and sacro-tuberous ligaments and the bones of the pelvis. Thus, it is attached:—*laterally*, to the anterior part of the iliac crest; *anteriorly*, to the inguinal ligament; *medially*, to the body of the pubis, to the margin of the pubic arch and to the ischial tuberosity; while *posteriorly*, it is continuous with the fascia of the gluteal region, through which it is fixed to the sacro-tuberous ligament, the coccyx, the sacrum, and the iliac crest.

Immediately below the inguinal ligament, it gives a linear attachment to the membranous layer of the superficial fascia;

and it is modified by the formation of the cribriform fascia and the saphenous opening.

At the knee, *on the front and on the sides*, it is attached to the capsule of the knee joint, the medial and lateral margins of the patella, the tuberosity of the tibia, the condyles of the tibia and of the femur, and to the head of the fibula. *Posteriorly*, it is stronger; it roofs over the popliteal fossa, where it is called the *popliteal fascia*; and it is continuous with the fascia of the back of the leg.

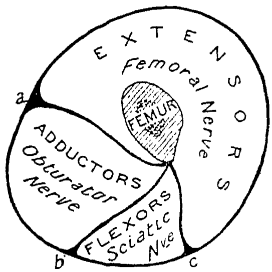


FIG. 105.—Diagram to show the arrangement of the three Intermuscular Septa and the three Osteo-Fascial Compartments of the Thigh. (After Turner)

a. Medial intermuscular septum.
b. Posterior intermuscular septum.
c. Lateral intermuscular septum.

Intermuscular Septa.—The fascia lata has other offices to perform besides that of investing the thigh and preserving its figure. From its deep surface, thin sheets pass into the limb and divide to form sheaths for the muscles and other structures.

The chief of these sheets are three partitions which pass from the fascia lata to the back of the femur. They are called the *lateral*, *medial* and *posterior intermuscular septa*. They divide the thigh into three compartments for the three great groups of muscles of the thigh, each associated with its nerve:—The **extensors** on the front, with the *femoral nerve*; the **flexors** or hamstrings on the back, with the *sciatic nerve*; and the **adductors** on the medial side, with the *obturator nerve* (Fig. 105).

These three septa will be disclosed in the subsequent dissection (p. 223). In the meantime, note that the medial and the lateral septa show as white lines on the surface of the fascia in the distal part of the thigh.

The extensor group is composed of four large muscles which collectively are called the **quadriceps femoris,** for they unite together before their insertion into the patella, and, therefore, resemble four heads of a single muscle. The ligamentum patellæ anchors the patella to the tibia, and acts as a continuation of the tendon of the quadriceps. A thin tendinous sheet extends downwards over the front of the patella from the tendon of the quadriceps to the ligamentum

patellæ; a synovial bursa may be found on the surface of this sheet and another under cover of it.

Patellar Bursæ.—Several synovial bursæ are situated in the patellar region, but all of them are seldom found in the same limb. Two of these bursæ are beyond the range of the present dissection. They are:—

1. A **suprapatellar bursa** that is always found above the patella between the tendon of the quadriceps and the front of the femur. It is a large bursa, and is important in that it nearly always opens into the cavity of the knee joint (p. 353).
2. A **deep infrapatellar bursa** placed between the lower end of the ligamentum patellæ and the upper end of the tibia; it is a constant bursa but is of small size (p. 350).

Two others that may have been found in the present dissection are:—

3. A **prepatellar bursa** which lies between the skin and the superficial fascia in front of the lower part of the patella; chronic enlargement of this bursa from pressure is known as "housemaid's knee".
4. A **subcutaneous infrapatellar bursa** which lies between the skin and the fascia in front of the tuberosity of the tibia and lower half of the ligamentum patellæ, and is sometimes divided into upper and lower parts.

Deep Dissection of Front of Thigh

Inguinal Ligament.—This ligament belongs to the abdominal wall, but the dissector of the Lower Limb must obtain some knowledge of its connexions before he proceeds farther with his dissection.

The **inguinal ligament** is the lower border of the aponeurosis of the external oblique muscle of the abdomen thickened and folded backwards upon itself. It presents, therefore, a rounded surface towards the thigh, and a grooved surface towards the abdomen. Its lateral extremity is fixed to the anterior superior iliac spine. Medially, it is attached to the pubic tubercle, and to the adjoining part of the pectineal line for nearly an inch. The inguinal ligament pursues an oblique course between its iliac and pubic attachments, and at the same time describes a gentle curve which is convex downwards. The fascia lata is attached to it along its whole length, and exercises traction upon it, so that the ligament loses its curvature when the fascia lata is divided.

The pectineal part of the inguinal ligament is a thin

expansion from its medial part, and is called the *lacunar ligament* (Fig. 106). This pectineal part is triangular in outline. One margin is continuous with the main ligament ; the other is attached to the pectineal line. The apex is at the pubic tubercle. Its base, which looks in a lateral direction, is sharp, crescentic and free, and abuts against the femoral sheath. It

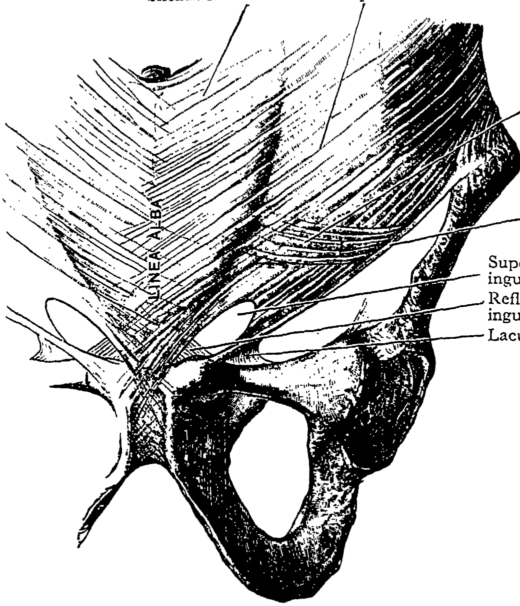


FIG. 106.—Dissection to show the Connexions of Inguinal Ligament.

is set obliquely, so that its femoral surface looks downwards and laterally, and this surface gives partial origin to the pectineus muscle.

The point on the inguinal ligament which is equidistant from the pubic symphysis and the anterior superior iliac spine is called the **mid-inguinal point.**

Dissection.—The *femoral sheath* was partly exposed when the cribriform fascia was removed (p. 196). To expose the sheath fully, cut through the fascia lata along the inguinal ligament, and carefully remove the part of it that is lateral to the saphenous opening (including the falciform margin). The removal of the loose fat will then bring the whole sheath into view. With the

handle of the knife or a blunt hook, isolate the sheath from the inguinal and lacunar ligaments.

Femoral Sheath.—The femoral sheath is a funnel-shaped, fascial tube that surrounds the uppermost inch and a half of the femoral vessels. The mouth of the funnel opens into the abdomen; the lower part gradually closes upon the vessels, and fuses with their coats about the level of the lower margin of the saphenous opening. The sides of

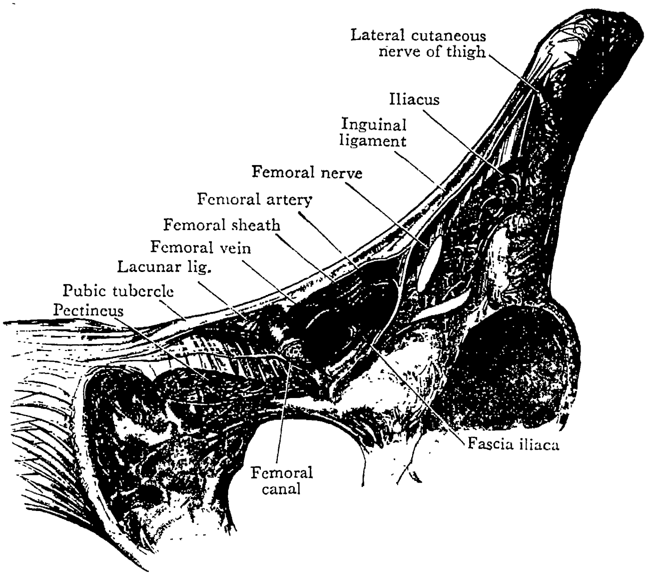


FIG. 107.—Dissection to show Femoral Sheath and the Structures which pass between Inguinal Ligament and Hip-Bone.

the sheath do not slope equally towards each other. The lateral wall is nearly vertical; the upper part of the medial wall is very oblique.

Constitution of the Femoral Sheath.—The sources from which the femoral sheath is derived, and the manner in which it is formed, must next be considered. This entails the study of some of the structures that form the walls of the abdomen.

The main part of the inguinal ligament is separated from the hip-bone by an elongated interval (Fig. 106).

The most medial part of the interval is occupied by the *lacunar ligament*. The rest of it is filled with muscles and vessels and nerves. Thus, from medial to lateral end of the interval, there are a portion of the *pectineus*, the *psoas major* and the *iliacus* muscles; the *femoral vessels* are in the space that separates the inguinal ligament from the pectineus and the psoas. The *femoral branch of the genito-femoral nerve* descends along the lateral side of the femoral artery; the *femoral nerve* is between the psoas and the iliacus; the *lateral cutaneous nerve* is between the iliacus and the lateral end of the inguinal ligament (Fig. 107).

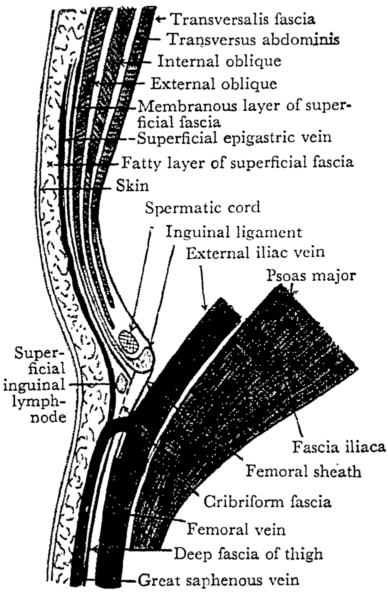


FIG. 108.—Diagram of Fasciæ and Muscles of Inguinal and Subinguinal Regions in the line of the Femoral Vein. Cf. Fig. 100.

The arrangement of the fascial lining of the abdominal cavity at this interval of communication between abdomen and thigh also requires attention. The lower part of the posterior wall of the abdomen, immediately above the thigh, is formed by the iliacus and psoas major muscles. They are covered with that part of the fascial lining of the abdomen which receives the name *fascia iliaca*. The anterior wall of the abdomen is lined, in like manner, with a portion of the general lining termed the *fascia transversalis*. Lateral to the femoral vessels, these two fascial layers become continuous with each other, and, at the same time, are attached to the back of the inguinal ligament (Fig. 100). It is behind this union that the iliacus, the femoral nerve, and the lateral cutaneous nerve are carried into the thigh. But the external iliac vessels (which become the femoral vessels in the thigh), with the femoral branch of the genito-femoral nerve, lie

anterior to the fascia iliaca, or, in other words, within the fascial lining of the abdomen; and, as they pass out of the abdomen, behind the inguinal ligament, they carry with them a funnel-shaped prolongation of the fascia, which is the femoral sheath.

The dissector will now readily understand that the *anterior wall* of the sheath is formed of *fascia transversalis* and the *posterior wall* of *fascia iliaca*—each of them being continued into the thigh from the corresponding wall of the abdomen (Fig. 108).

Dissection.—Open the femoral sheath by three vertical incisions through the anterior wall—one over the femoral artery, another over the femoral vein in the line of the great saphenous vein, and the third a little medial to the upper part of the vein. The first two should extend downwards for an inch and a half from the inguinal ligament, the most medial for only half an inch or less.

Interior of the Femoral Sheath.—A little dissection will show that the sheath is divided into three compartments by two antero-posterior septa. The femoral artery and femoral branch of the genito-femoral nerve occupy the *lateral compartment*; the femoral vein fills the *intermediate compartment*; the *medial compartment* lodges a little loose areolar tissue, a small lymph-node, and some lymph-vessels. This last compartment, from its relation to femoral hernia, has the special name of *femoral canal* applied to it.

Femoral Canal.—The boundaries and extent of the femoral canal must be very thoroughly studied. The best way to begin is to introduce the little finger into the canal and push it gently upwards. The length of the canal is not nearly so great as that of the other two compartments. Indeed, it is not more than half an inch long. It rapidly diminishes in width from above downwards, and its lower end is closed by the fusion of its walls.

The upper end or mouth of the canal is called the **femoral ring.** It is closed by a plug of fat called the *femoral septum*; and the peritoneum—the innermost, glistening lining of the abdominal walls—overlies the fat, and is slightly dimpled into the ring. It is wide enough to admit the tip of the little finger. With your finger-tip in the ring, feel its boundaries :—*anteriorly*, the inguinal ligament ; *medially*, the lacunar ligament ; *posteriorly*, the pectineal line of the pubic bone ; *laterally*, the femoral vein.

The canal lies on the pectineus muscle and its fascia; and the upper margin of the saphenous opening crosses its upper part. Lower down, the canal is covered by the cribriform fascia, and is usually crossed by the superficial external pudendal artery.

Femoral Hernia.—Femoral hernia is the name applied to the protrusion of some of the contents of the abdominal cavity through the *femoral canal* into the thigh. The arrangement of the parts which occupy the interval between the hip-bone and the inguinal ligament has been carefully considered, and the dissector should therefore be in a position to understand how the occurrence of such a protrusion is possible (Fig. 107). On the medial side of the femoral sheath, the interval is closed by the lacunar ligament (p. 206), which, by its strength and firm connexions, constitutes an impassable barrier. On the lateral side of the sheath, a hernial protrusion is equally impossible. There, the fascia transversalis on the anterior wall of the abdomen becomes continuous with the fascia iliaca on the posterior wall, and, along the line of union, both are firmly attached to the inguinal ligament.

It is in the region of the femoral sheath, then, that femoral hernia takes place. The three compartments of the sheath open above into the abdominal cavity, but there is an essential difference between the medial opening and the other two. The lateral two are occupied by the artery and the vein. The femoral canal, or most medial compartment, is occupied by fat which yields under pressure. Further, its widest part is the upper opening or *femoral ring*. It has been noted that the ring is wide enough to admit the point of the little finger, and it forms a weak point in the parietes of the abdomen—weaker in the female than in the male, seeing that, in the female, the distance between the iliac spine and the pubic tubercle is relatively greater, and that, in consequence, the femoral ring is wider. Femoral hernia, therefore, is more common in the female.

When attempts are made to reduce a femoral hernia, it is necessary that the course which the protrusion has taken should be kept constantly before the mind of the operator. In the first instance, it passes downwards for a short distance. It then turns forwards and bulges through the saphenous opening. Should it still continue to enlarge, it first bends upwards over the inguinal ligament, and then pushes its way upwards and laterally towards the anterior superior iliac spine. The protrusion is thus bent upon itself, and, if it is to be reduced successfully, it must be made to retrace its steps. In other words, it must be drawn down, and then pushed gently backwards and upwards. The position of the limb during this procedure must be attended to. When the thigh is fully extended and rotated laterally, all the fascial structures in the neighbourhood of the femoral canal are made tense. When, on the other hand, the limb is flexed at the hip joint and rotated medially, the upper margin of the saphenous opening, and even the lacunar ligament, are relaxed. That, then, is the position in which the limb should be placed during the reduction of the hernia.

As the hernia descends it carries before it the various layers which it meets. First it pushes before it the peritoneum, and that forms the *hernial sac*. The *coverings* of the sac, from within outwards, are:—(1) the femoral septum; (2) the wall of the femoral sheath; (3) the cribriform fascia; and, lastly, (4) the superficial fascia and skin.

The femoral canal, as already noted, is surrounded by very unyielding

structures. Strangulation of femoral hernia (*i.e.*, cutting off the blood-supply of its contents) due to pressure is, therefore, of very common occurrence. The base of the lacunar ligament and the upper margin of the saphenous opening are especially apt to bring about that condition owing to the fact that they are sharp and tense.

Abnormal Obturator Artery.—The account of the surgical anatomy of femoral hernia cannot be complete without mention of the relation which the obturator artery frequently bears to the femoral ring. This artery passes through the obturator foramen to reach the upper part of the medial side of the thigh (p. 272), and its usual origin is from the internal iliac artery in the pelvis. In nearly 30 per cent of bodies, however, it springs, on one or on both sides, from the inferior epigastric artery on the deep aspect of the anterior abdominal wall (as an enlargement of the pubic branch of that artery). It must then pass behind the pubic bone to gain the upper part of the obturator foramen, and it has a variable relation to the femoral ring. If it runs down, to reach the pelvis, across the deep aspect of the base of the lacunar ligament, it is in a position of great danger, since that is the structure against which the surgeon's knife is generally directed for the relief of an irreducible femoral hernia.

These points are within the province of the dissectors of the Abdomen, and reference should therefore be made to Vol. II, p. 194, and the accompanying illustration (Fig. 102).

The boundaries and contents of the femoral triangle, which occupies the upper third of the front of the thigh, must now be dissected.

Dissection.—The lateral boundary of the triangle is the *sartorius* muscle, and the medial boundary is the medial border of the *adductor longus* (Fig. 109). Clean these muscles down to the apex of the triangle where they meet, preserving the nerves in relation to the sartorius.

Now, place a block under the knee in order to flex the hip joint and relax the boundaries and contents of the triangle.

Raise the *femoral nerve* from the groove between the psoas and iliacus muscles on a blunt hook ; and note that it soon ends in a number of muscular and cutaneous branches. Secure the *nerve to the pectineus* first, and endeavour to trace it medially, behind the femoral artery, to its muscle. Then, clean the other branches of the femoral nerve till they leave the triangle, avoiding injury to the *lateral circumflex artery* which passes laterally among these nerves near their origin.

Now, clean the vessels, retaining the large venous trunks, but removing the venæ comitantes of the smaller arteries. Raise the *femoral artery*, and clean it as far as the apex of the triangle. Secure and clean a small artery called the *deep external pudendal.* It springs from the upper part of the femoral artery and runs medially. You have probably found the root of the *profunda artery* already. It is a large artery that springs from the femoral artery about two inches below the inguinal ligament. Follow it downwards, amidst the fat behind the femoral vessels, till it leaves the triangle. At the same time, clean the *profunda vein*, which lies in front of its artery. Two large arteries spring from the profunda near its origin. They are the *lateral* and *medial circumflex arteries.*

Trace the lateral artery as far as the sartorius. Trace the medial one backwards as far as possible into the fat behind the femoral vessels. Preserve the proximal parts of the circumflex veins, and note that they end in the femoral vein. Not uncommonly, one or both of the circumflex arteries spring from the femoral artery.

As you clean the femoral vein, trace the nerve to the pectineus muscle behind it. Clean the pectineus, and look for the anterior division of the *obturator nerve* in the interval between it and

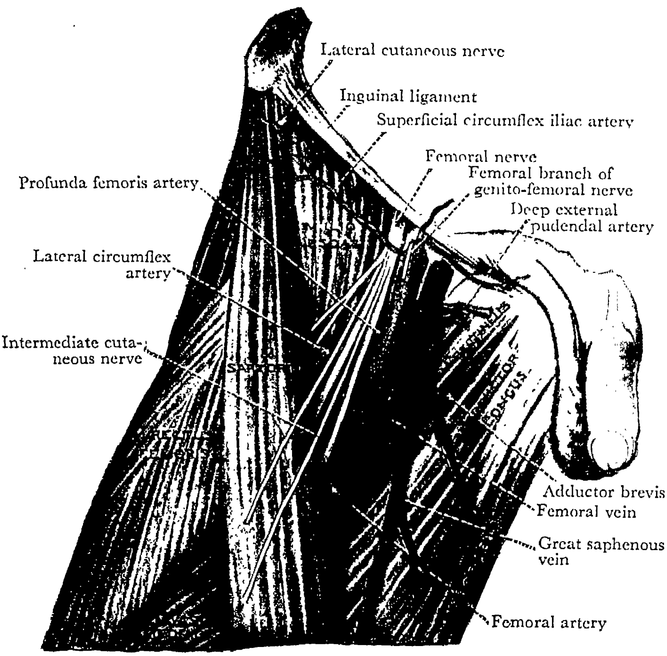


FIG. 109.—Dissection of Right Femoral Triangle.

the adductor longus, as it descends behind them in front of the *adductor brevis*.

Next, clean the surface of the iliacus and psoas major. And, lastly, remove the mass of fat from the angle between the psoas and pectineus—disentangling the medial circumflex artery, which passes backwards between those two muscles.

Femoral Triangle.—This is the name given to the hollow that occupies a great part of the upper third of the thigh (Fig. 109). Its *base* is the inguinal ligament. Its

lateral boundary is the medial border of the sartorius; its *medial boundary* is the medial border of the adductor longus; and those two muscles meet at the *apex*. The apex is continuous with a narrow intermuscular space, called the *adductor canal*, through which the femoral vessels travel down to the popliteal fossa.

The *roof* is composed of the skin and fasciæ. The superficial fascia contains the superficial inguinal lymph-nodes with their lymph-vessels, the femoral branch of the genito-femoral nerve, branches of the ilio-inguinal nerve, the superficial branches of the femoral artery with their companion veins, and the upper part of the great saphenous vein; most of these structures pierce the deep fascia of the roof.

The *floor* is composed of muscles—adductor longus, pectineus, psoas major and iliacus, from medial to lateral side. The adductor brevis may appear in the floor between the pectineus and adductor longus. The floor slopes backwards towards the centre from the lateral and medial boundaries; the space is triangular, therefore, in section as well as in outline. The central hollow is occupied by a mass of fat which contains the profunda and medial circumflex vessels, behind the main femoral vessels.

The main **contents** of the triangle are as follows :—

1. The **femoral vessels** traverse the triangle from base to apex; the vein is medial to the artery at the base of the triangle, and behind it at the apex.
2. The **deep external pudendal artery** is a small artery that arises from the medial side of the femoral artery near the base of the triangle. It runs a variable course medially and pierces the deep fascia to be distributed to the scrotum in the male and to the labium majus in the female.
3. The **profunda femoris artery** springs from the lateral side of the femoral, curves downwards behind it and leaves the triangle by passing behind the adductor longus close to the femur. The **profunda vein** is in front of its artery and ends in the femoral vein.
4. The **lateral** and **medial circumflex arteries** spring from the profunda near its origin. The lateral artery runs laterally among the branches of the femoral nerve and leaves the triangle behind the sartorius. The medial artery passes backwards and disappears through the floor of the triangle between the psoas and the pectineus. The **circumflex veins** end in the femoral vein.
5. Three or four **deep inguinal lymph-nodes** lie along the medial side of the femoral vein. They receive afferent vessels from the superficial inguinal nodes and from the deep parts of the limb; and they send their efferent vessels to the nodes that lie in the abdomen around the external iliac artery.
6. The **femoral branch of the genito-femoral nerve**, already noticed (p. 200), is distributed to the skin over the femoral triangle.

7. The **lateral cutaneous nerve** of the thigh crosses the lateral angle of the triangle; it has been examined already (p. 200).
8. The **femoral nerve** is described fully on p. 220.

Before the contents of the triangle are studied further,

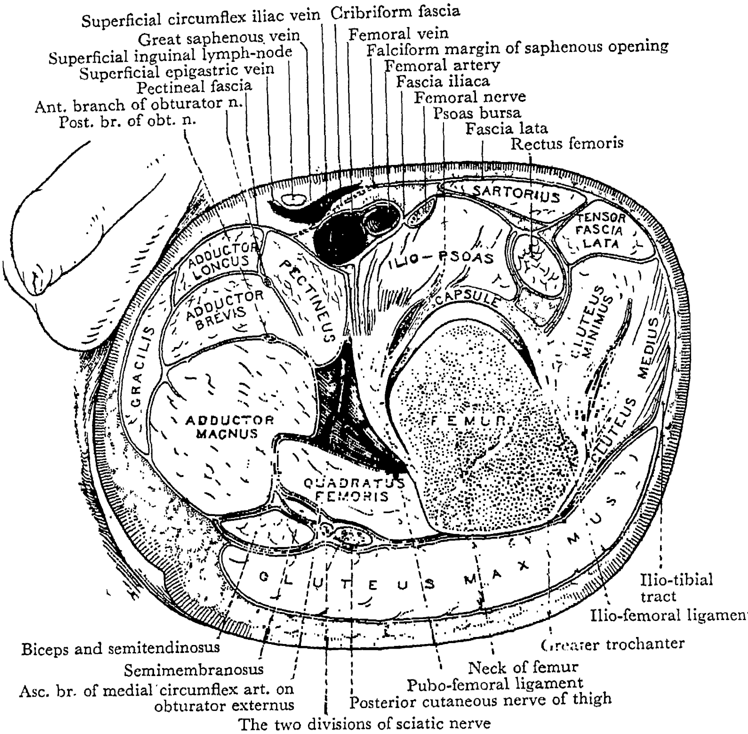


FIG. 110.—Dissection of Oblique Section through Upper Part of Thigh, showing Relation of the Fascia to Muscles.

another stage of the dissection of the front of the thigh must be carried out.

Dissection.—Complete the cleaning of the *sartorius* right down to its insertion into the tibia.

Next, make a vertical cut through the deep fascia from the tubercle of the iliac crest to the lateral margin of the patella, and remove the deep fascia between the incision and the sartorius; this will leave the main part of the ilio-tibial tract in position,

but will disclose the *tensor fasciæ latæ*, on the lateral side of the upper part of the sartorius, and portions of the four parts of the quadriceps extensor muscle.

Identify (*a*) the *rectus femoris*, extending down the middle of the thigh ; (*b*) part of the *vastus lateralis*, at the lateral side of the rectus ; (*c*) a small part of the *vastus intermedius* which usually appears to be the lower part of the vastus lateralis ; (*d*) part of the *vastus medialis* that fills the space between the lower parts of the rectus femoris and sartorius.

Trace the *lateral circumflex artery* behind the sartorius and the rectus femoris, and follow its three branches ; the descending branch follows the anterior border of the vastus lateralis and indicates the line along which the vasti are fused.

Separate the sartorius and the tensor fasciæ latæ ; evert the tensor and look for its nerve a little above its middle. The nerve is a branch of the *superior gluteal nerve*. Follow it backwards to the point where it appears between two muscles of the gluteal region, the *gluteus medius* and *gluteus minimus*.

Now, clean the *ascending branch of the lateral circumflex artery*, and, as you remove the fat, remove also the septum of fascia between the sartorius and the tensor. Then, clean the upper part of the *rectus femoris*. It arises by two heads which very soon join together. Follow them up to their attachments.

Come back to the anterior borders of the *gluteus medius* and *minimus*; define and clean them. They are often partly fused together ; but the nerve to the tensor, emerging from between them, is the guide to the line of separation. The gluteus medius is often fused also with the deep surface of the tensor.

Turn now to the middle third of the medial side of the thigh. Pull the sartorius laterally. Clean the ribbon of fibrous tissue that you find under cover of the muscle ; its edges are attached to the vastus medialis and to the adductors, and it roofs over the *adductor canal*. Split the fibrous roof, and clean the contents of the canal—femoral vessels, saphenous nerve, and nerve to vastus medialis.

Sartorius.—This is a long, slender, strap-like muscle with parallel fibres—a characteristic that enables it to be recognised when a portion of it is exposed in the living limb.

It arises chiefly from the anterior superior iliac spine, crosses the upper third of the thigh obliquely, and then descends almost vertically to the posterior part of the medial side of the knee ; finally, it curves forward to end in a thin tendon which expands to be inserted into the upper part of the medial surface of the tibia (Fig. 127, p. 260). Note that the muscle is fleshy almost to its lower end.

Its upper, oblique part is the lateral boundary of the femoral triangle. Next, it covers the fibrous roof of the adductor canal, superficial to the lower half of the femoral vessels. At the knee, when the limb is extended, it produces a vertical fleshy ridge far back on the medial side of the

knee, and has to curve forwards to its insertion; but when the leg is flexed, it slips backwards into the medial boundary of the popliteal fossa, and proceeds straight to its insertion. Its tendon is thin and fairly wide and is superficial to the

FIG. 111.—Dissection of Adductor Canal in the Right Thigh. A portion of the Sartorius has been removed.

tendons of the gracilis and semitendinosus, but is separated from them by a bursa; and it is inserted in front of them.

The sartorius is supplied by the *femoral nerve*. It acts on both the hip joint and the knee joint, and comes into prominence when these joints are flexed and the thighs are rotated

to bring the limbs into the position adopted by the working tailor. (*Sartor* = a tailor.)

Adductor Canal.—When the femoral artery leaves the femoral triangle, it is continued downwards, on the medial side of the thigh, in a deep furrow bounded anteriorly by the vastus medialis muscle, and posteriorly by the adductor longus and magnus muscles. At its upper end, this furrow is continuous with the deeper, wider, and more apparent hollow which has been described as the femoral triangle. Further, the furrow is converted into a canal, triangular on cross section, by a strong fibrous membrane which stretches

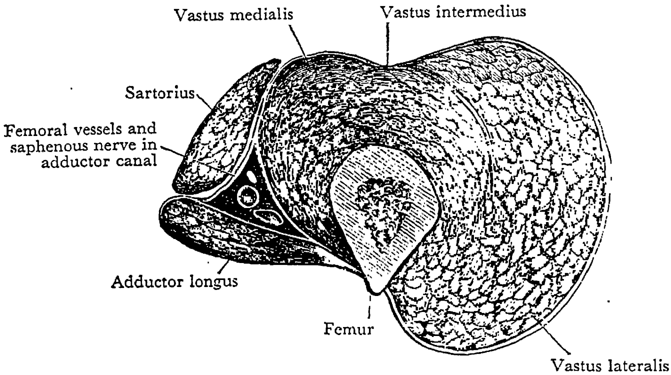


FIG. 112.—Transverse Section through Adductor Canal.

across it, and upon the surface of which the sartorius muscle is placed (Fig. 112). The tunnel thus formed is called the *adductor canal*.[1] The fibrous membrane which roofs in the canal stretches from the fascial covering of the adductors to the fascial covering of the vastus medialis. When it is traced upwards, it is seen to become thin and ill-defined; inferiorly, however, it becomes dense and strong, and at the distal end of the canal it presents a thick, sharply defined margin. The posterior wall of the canal, in its lowest part, where it is formed by the adductor magnus, presents a deficiency or aperture which leads backwards into the popliteal fossa. The appearance and construction of this

[1] Long known as *Hunter's Canal.* JOHN HUNTER's (1728–1793) operation for the cure of popliteal aneurysm by ligature of the femoral artery in this canal is a landmark in the history of vascular surgery.

aperture will be studied at a later stage. It is called the *tendinous (adductor) opening*.

The femoral vessels and the saphenous nerve traverse the adductor canal. The vessels leave the canal by inclining backwards through the opening in the adductor magnus. The saphenous nerve escapes from the canal by passing under cover of the distal margin of the fibrous roof. The nerve to the vastus medialis enters the upper end of the canal, and its branches descend for some distance between the vastus and its fascia before they enter the muscle.

Femoral Artery.—The femoral artery is the direct continuation of the external iliac artery of the abdomen, and is the great arterial trunk of the lower limb. It begins behind the inguinal ligament, at the mid-inguinal point (p. 206), and it descends through the upper two-thirds of the thigh to the opening in the adductor magnus, through which it passes into the popliteal fossa to become the popliteal artery. The course of the femoral artery may be marked on the surface, when the thigh is slightly flexed, abducted and rotated laterally, by the upper two-thirds of a line drawn from the mid-inguinal point to the adductor tubercle. The extent of the artery in the femoral triangle and in the adductor canal varies with the width of the sartorius, but usually the upper half is in the triangle and the lower half in the canal.

Relations.—The relations which the artery bears to the femur are important. As it enters the thigh it leaves the brim of the pelvis and lies in front of the medial part of the head of the femur, from both of which it is separated by the psoas major muscle. The artery is more effectively compressed opposite the brim of the pelvis than opposite the head of the femur, because the psoas opposite the brim forms a flatter bed and the vessel is less apt to slip from under the fingers. During the remainder of its course through the femoral triangle, the artery is not in close relation to the bone; it crosses in front of the angular interval between the neck and shaft of the femur. Towards the apex of the triangle, however, it comes into relation with the medial surface of the shaft of the femur, being separated only by the posterior part of the vastus medialis, which is thin there; that position it holds to its termination, but, owing to the obliquity of the medial surface of the femur, the terminal part of the artery is well behind the bone.

In the femoral triangle, the artery is quite superficial, being covered only by skin and fasciæ and crossed at the apex of the triangle by the medial cutaneous nerve. The only structure related to the artery *medially* is the femoral vein, in the upper part of the triangle; but it takes up a position behind the artery in the lower part of the triangle. *Lateral* to the artery are the femoral nerve and its branches.

Behind the artery are the muscles of the floor of the triangle. But it is separated from the pectineus by a mass of fat which contains the profunda vessels, and from the adductor longus by the femoral vein. At the apex of the triangle, the order of structures, from before backwards, is—femoral artery, femoral vein, adductor longus, profunda vein and profunda artery; in a stab-wound at that point all four vessels may be severed.

In the adductor canal, the artery is separated from the adductors longus and magnus by the femoral vein, which is posterior to the artery in the upper part of the canal and postero-lateral in the lower part; and the adductor longus separates the femoral vessels from the profunda vessels. The nerve to the vastus medialis is lateral to the artery in the upper part of the canal; and the saphenous nerve crosses gradually in front of the artery from lateral to medial side.

Branches.—In addition to the three small superficial arteries of the groin and the deep external pudendal, the artery gives off, in the femoral triangle, the profunda femoris, which will be traced in a later dissection. The branches which arise in the subsartorial canal are muscular twigs and the *descending genicular artery*, which springs from the femoral trunk a short distance above the opening in the adductor magnus. It gives branches to muscles and to the knee joint, and one accompanies the saphenous nerve to the medial side of the knee and the leg.

Femoral Vein.—This large vessel is the direct continuation of the popliteal vein. It begins at the opening in the adductor magnus, traverses the adductor canal and the femoral triangle, and ends behind the inguinal ligament, where it becomes the external iliac vein. It accompanies the femoral artery, but their relations to each other alter at different stages of their course. In the lower part of the adductor canal, the vein is postero-lateral to the artery; it inclines medially as it ascends, and, for a considerable

distance, is directly behind the artery; but in the upper part of the femoral triangle it is on the medial side of the artery. Slit the femoral vein open with the scissors. Several valves will then be seen. One is almost invariably found immediately above the entrance of the profunda vein.

Tributaries.—The veins that join the femoral vein do not correspond strictly to the branches of the artery. The superficial veins of the groin end in the great saphenous vein, which itself joins the femoral; and the femoral receives the circumflex veins direct, although the corresponding arteries are usually branches of the profunda.

Femoral Nerve.—This thick nerve (L. 2, 3, 4) arises within the abdomen from the lumbar plexus (Figs. 102, 103). It descends in the groove between the iliacus and psoas major, and enters the thigh behind the inguinal ligament and the fascia iliaca. In the thigh, it is lateral to the femoral artery, and is separated from it by a small portion of the psoas major muscle and the femoral sheath (Fig. 107).

It ends about an inch below the inguinal ligament, having resolved itself into a number of muscular and cutaneous nerves :—

Muscular :	Cutaneous :
To pectineus.	Medial cutaneous, of thigh.
To sartorius.	Intermediate cutaneous, of thigh.
To quadriceps femoris.	Saphenous.

The supply to the quadriceps femoris is by separate nerves to its four heads—rectus femoris and the three vasti. The *articular* nerves arise from these four muscular branches. The nerve to the rectus femoris sends a slender branch to the hip joint, and the nerves to the vasti send filaments down through the muscles to the knee joint. Thus, the nerves to the heads of the quadriceps that act only on the knee joint send branches to that joint; the nerve to the head that acts also on the hip joint sends a branch to that joint.

The *intermediate cutaneous nerve* (L. 2, 3) sometimes pierces the medial border of the sartorius, and it is distributed by two branches which have been examined already (p. 201). The distribution of the lateral cutaneous nerve also should be reviewed (p. 200).

The *medial cutaneous nerve* (L. 2, 3) inclines downwards and medially along the medial margin of the sartorius, crosses in front of the femoral artery at the apex of the

femoral triangle, and divides into an anterior and a posterior branch, already traced (p. 202).

The *saphenous nerve* (L. 3, 4) is the longest branch of the femoral nerve and the only one that has its main distribution below the knee. It is fully described on p. 305, where its course will be traced to the medial border of the foot. Note here that it accompanies the femoral artery in the adductor canal, emerges from the canal by passing under cover of the lower border of its fibrous roof, and that it appears from under cover of the sartorius at the medial side of the knee.

The *nerve to the pectineus* arises a short distance below the inguinal ligament, and runs medially and downwards behind the femoral vessels to reach its destination.

The *nerves to the sartorius* are two or three in number. As a rule, they take origin in common with the intermediate cutaneous nerve.

The *nerves to the rectus femoris* (usually two) sink into the deep surface of that muscle. The upper one supplies an articular twig to the hip joint.

The *nerve to the vastus medialis* accompanies the saphenous nerve into the adductor canal, and divides into branches which soon sink into the muscle. It sends an articular branch to the knee joint.

The *nerve to the vastus lateralis* passes behind the rectus femoris, and runs downwards with the descending branch of the lateral circumflex artery to enter the anterior border of the muscle. Usually it gives a branch to the knee joint.

The *nerves to the vastus intermedius* are two or three in number, and they sink into its anterior surface. The most medial of them is a long slender nerve which can be traced downwards, along the medial edge of the vastus intermedius to the *articularis genu* muscle. Its terminal filaments are given to the knee joint.

Lateral Circumflex Artery.—This is the largest branch of the profunda femoris artery. It arises near the origin of the profunda, and runs laterally, among the branches of the femoral nerve and then under cover of the sartorius, to the deep surface of the rectus femoris, where it ends by dividing into ascending, transverse, and descending branches.

The *ascending branch* reaches the gluteal surface of the ilium by ascending along the intertrochanteric line of the femur under cover of the tensor fasciæ latæ. It supplies the hip joint and the adjacent muscles. The *transverse branch* is of small size. It sinks backwards through the vastus lateralis, and anastomoses with other arteries at the back of the

femur. The *descending branch* runs downwards along the anterior border of the vastus lateralis, gives branches to the quadriceps femoris, and sends a long branch down through the vastus lateralis to the capsule of the knee joint.

Tensor Fasciæ Latæ.—This is a short, thick muscle that lies at the junction of the gluteal region and the upper part of the front of the thigh. It is enclosed between two layers of fascia which are continuous with the ilio-tibial tract. The muscle arises from the anterior part of the iliac crest, and passes downwards and slightly backwards to be inserted into the ilio-tibial tract an inch or two below the level of the greater trochanter. It is supplied by the superior gluteal nerve.

Ilio-tibial Tract.—The thick band of fascia lata on the lateral side of the thigh which receives this name should now be examined, and its connexions ascertained.

It is attached above to the tubercle of the iliac crest, and below to the lateral condyle of the tibia, the capsule of the knee joint and the patella. From above downwards, it covers part of the gluteus medius, the greater trochanter, the vastus lateralis, part of the vastus intermedius, the lateral condyle of the femur, and the knee joint.

Two muscles are inserted into it :—the gluteus maximus behind, at the level of the greater trochanter; and the tensor fasciæ in front, below the greater trochanter. The lower part of the tract serves, therefore, as an aponeurotic tendon by means of which those two muscles gain insertion into the lateral condyle of the tibia; and the whole tract serves as a powerful brace which, in the erect posture, helps to steady the pelvis and keeps the knee joint firmly extended.

Above the insertion of the gluteus maximus, the posterior border of the tract is continuous with the thick fascia on the superficial surface of the gluteus medius, and its anterior border splits to enclose the tensor fasciæ latæ. Below the gluteus maximus, the borders of the tract merge into the rest of the fascia lata; and its deep surface is connected with the lateral supracondylar ridge and the linea aspera by the lateral intermuscular septum.

Dissection.**—To see the *lateral intermuscular septum* and the relation of the vastus lateralis to the femur, detach the muscle from its origin and turn it forwards from its bed.**

Intermuscular Septa.—There are three intermuscular septa of the thigh: lateral, medial, and posterior (p. 204). The lateral is strong; the other two are weak and, except in the lower part of the thigh, are represented merely by thin fascial layers on the front and back of the adductor muscles.

The *lateral intermuscular septum* is a fibrous partition that separates the vastus lateralis and intermedius from the short head of the biceps femoris — one of the muscles of the back of the thigh. The septum springs from the deep surface of the ilio-tibial tract, and its deep border is attached to the lateral supracondylar ridge and to the linea aspera. Parts of the vastus intermedius and vastus lateralis arise from its anterior surface, and some of the fibres of the short head of the biceps femoris spring from its posterior surface, and can be seen shining through it at this stage of the dissection.

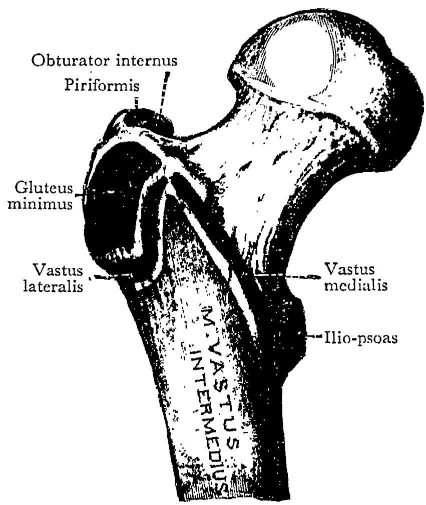


FIG. 113.—Front of Upper Part of Femur with Attachments of Muscles mapped out.

The *medial* and *posterior intermuscular septa* are very thin, and it is difficult to demonstrate them as separate structures. The most distinct part of the medial septum is in front of the distal part of the adductor magnus; it springs from the fascia lata behind the posterior border of the sartorius and passes to the medial supracondylar ridge. Similarly, the posterior septum is the thin layer between the adductor magnus and the semi-membranosus; and its lower part is behind the tendon of the adductor magnus.

Quadriceps Femoris.—The quadriceps femoris muscle

s composed of four portions :—the *rectus femoris*, which is placed in the anterior part of the thigh, and is quite distinct from the others, except at its insertion ; the *vastus lateralis*, the *vastus intermedius*, and the *vastus medialis*, which clothe the front and sides of the shaft of the femur, and are more or less blended with one another. The vasti and the rectus are all supplied by the *femoral nerve*.

Rectus Femoris.—The rectus muscle arises by two tendinous heads, which were exposed when the dissection was carried deeply in the interval between the sartorius and tensor of the fascia lata (p. 215). The *straight head* springs from the anterior inferior iliac spine (Fig. 129). The *reflected head* arises, under cover of the gluteus minimus, from a marked impression on the ilium immediately above the acetabulum (Fig. 117). These two tendinous attachments of the muscle take the strain in varying degree according to the extent of flexion or extension at the hip joint.

The two heads of origin of the rectus femoris join at a right angle, immediately beyond the margin of the acetabulum, and form a strong, flattened tendon, which gives place to a fusiform, fleshy belly. The tendon of origin spreads out on the anterior surface of the upper part of the muscle in the form of an aponeurosis. About three inches above the knee joint, the rectus femoris ends in a strong tendon of insertion which is prolonged for some distance upwards on its deep surface in the form of an aponeurosis. As it nears the knee the tendon of the rectus femoris joins the other tendons of the quadriceps, and forms with them a common tendon which is inserted into the upper border of the patella.

Vastus Lateralis.—This muscle forms the greater part of the fleshy mass on the lateral side of the thigh. Its superficial stratum is a glistening aponeurosis. It overlaps the vastus intermedius, and is partly blended with that muscle ; its anterior border is therefore ill-defined, and the descending branch of the lateral circumflex artery is the best guide to it.

The vastus lateralis has a long, linear origin from the root of the greater trochanter and the back of the femur down to the supracondylar ridge (Figs. 113, 114, 130). The fleshy fibres are, for the most part, directed downwards and forwards. By means of the common tendon of insertion the muscle gains attachment to the patella, and, at the same time, gives an expansion to the capsule of the knee joint.

Dissection.—**Divide the rectus femoris about its middle, and pull the lower part forcibly downwards. The narrow interval between the tendons of the *vastus intermedius* and *vastus medialis* will then become apparent, and will serve as a guide to the line along which the muscles must be separated. Another guide to the line of separation is a long, slender nerve that descends to supply the *articularis genu muscle*; it runs along the medial edge of the vastus intermedius. Raise the anterior border of the vastus medialis, and divide it transversely about two inches above the patella; pull the muscle medially, and examine its origin.**

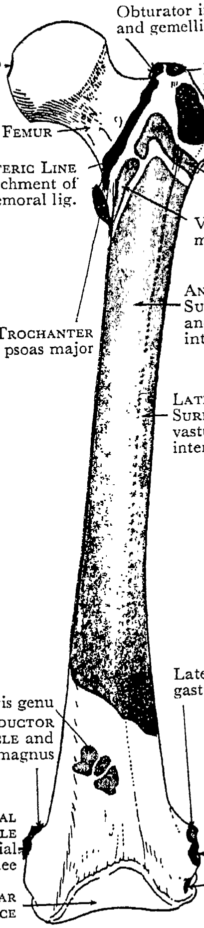


FIG. 114.—Front of Femur with Muscular Attachments mapped out.

Vastus Medialis.—The vastus medialis is intimately connected with the vastus intermedius, but they are seldom fused together.

It has a long linear origin chiefly from the intertrochanteric and spiral lines and the linea aspera (Figs. 114, 130); and it should be noted that so few muscle bundles arise from the medial surface of the femur that it is almost bare. The fleshy fibres are directed downwards and forwards, and end in the common tendon of the quadriceps muscle, which is inserted into the patella and becomes connected with the capsule of the knee joint.

Vastus Intermedius.—The vastus intermedius covers and arises from the anterior and lateral surfaces of the shaft of

GLUTEAL REGION

The **first day's work** should be :—(1) Surface-anatomy; (2) dissection of the parts superficial to the gluteus maximus; (3) cleaning and reflecting that muscle; (4) tracing and defining the various nerves and blood-vessels which enter its deep surface. On the **second day,** dissect the parts exposed by the reflexion of the gluteus maximus.

Surface Anatomy (Figs. 98, 115).—In the lower part of the region, the **buttock** forms a smooth, rounded elevation which is separated from its fellow by the **natal cleft,** and limited inferiorly by the **gluteal fold.** The groove below the fold is the result of a firm linear attachment of the skin to the deep fascia by fibrous strands that pass through the superficial fascia. The bulging prominence of the buttock is due to a thick layer of fat and the lower part of a large muscle called the **gluteus maximus** that overlie the ischium, which is the skeleton of the buttock. The lower end of the ischium and the lower part of its posterior surface are greatly roughened by the attachment of muscles, and the rough area is called the **ischial tuberosity.** Though the tuberosity is hidden deeply under the fat and gluteus maximus, it can be felt if you place your finger in the medial part of the fold of the buttock and press upwards. Note that the fold of the buttock does *not* correspond to the lower border of the gluteus maximus, which crosses the fold obliquely along a line from the coccyx to the lateral side of the thigh a hand-breadth below the trochanter.

The terms "buttock" and "gluteal region" are not synonymous. The "region" extends both upwards and forwards for a considerable distance beyond the buttock, and is limited superiorly by the **iliac crest** (p. 190). On the side of the trunk, in a muscular man, the outermost muscle of the abdomen (*obliquus externus*) bulges out over the crest so that the crest lies in a groove. Find the highest point of the crest (which is at the level of the fourth lumbar spine), and note the downward slope of the crest both anteriorly and posteriorly. Its anterior part has been examined already. A line drawn from its anterior superior spine to the front of the greater trochanter marks the anterior limit of the gluteal region, and its junction with the upper part of the front of the thigh.

Trace the iliac crest backwards to its posterior end at the **posterior superior iliac spine.** This spine does not form a

surface prominence; on the contrary, it lies in the floor of a dimple of the skin. The dimple is situated a little above

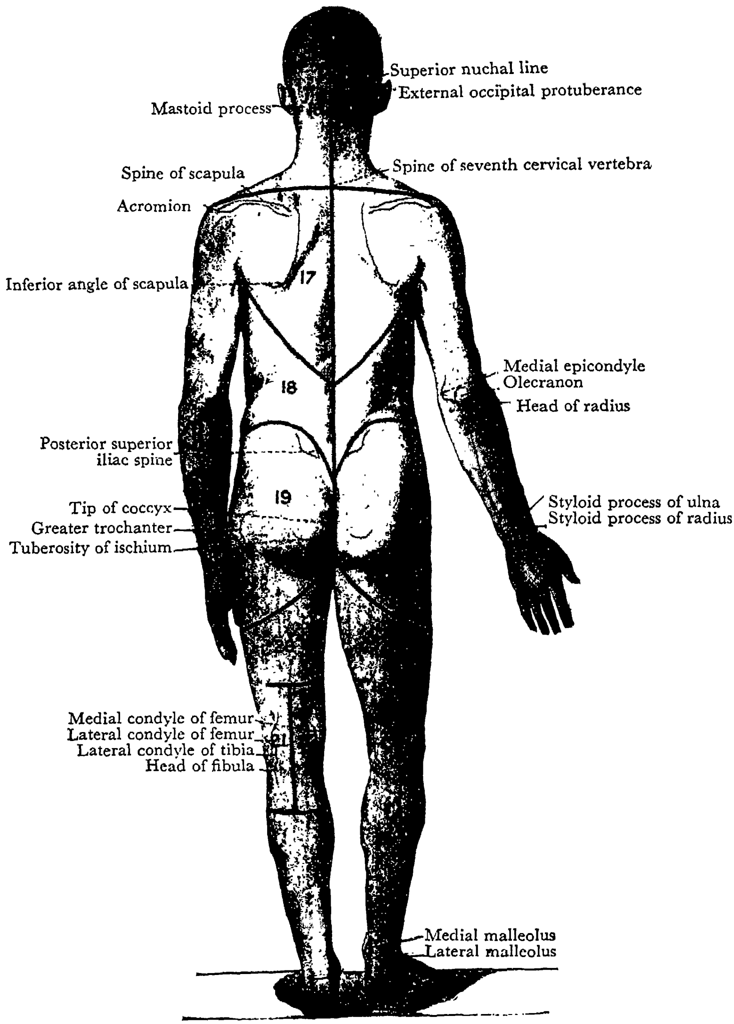


FIG. 115.—Landmarks and Incisions. For the bony landmarks, cf. Fig. 98, Pl. XXIV.

the buttock, about three finger-breadths from the median plane, and is at the level of the second spine of the sacrum, opposite the middle of the sacro-iliac joint.

The area between the right and left dimples corresponds to the back of the **sacrum.** The sacrum has usually three tubercles or spines in the median plane, about an inch apart. The second spine is midway between the dimples, and is the guide to the other two spines. The natal cleft begins at or near the third spine, and deepens as it extends downwards; the lower part of the sacrum and the coccyx lie in its floor. The **coccyx** reaches almost to the anus, and can be distinguished from the sacrum, because it moves slightly under pressure, except in old people.

Press firmly on the region between the lower part of the sacrum and the ischial tuberosity. The resistance encountered is due to a strong band, called the **sacro-tuberous ligament,** which is felt through the fat and the gluteus maximus.

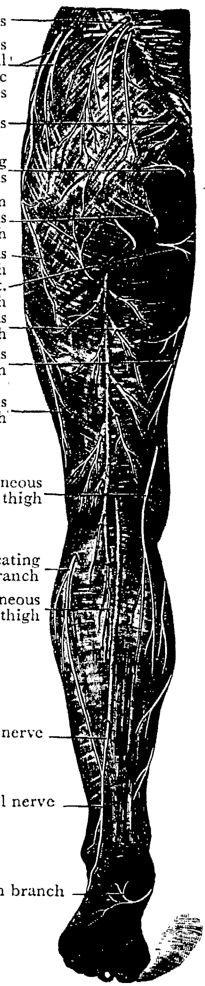


FIG. 116.—Cutaneous Nerves on Back of Lower Limb. See also Fig. 104, p. 202.

***Dissection.*—Reflexion of Skin.—*Incisions* (Fig. 115).—(1) From the posterior superior iliac spine along the iliac crest, as**

far forwards as the position of the body will permit ; (2) from the posterior end of this incision downwards and medially to the median line in the sacral region, and then perpendicularly to the tip of the coccyx ; (3) from the tip of the coccyx downwards and laterally over the back of the thigh, to the middle of the lateral side of the thigh.

Raise the flap of skin (19) thus marked out, and throw it laterally. On the *right* side of the body, begin at the iliac crest and work downwards and forwards ; on the *left* side, begin over the coccyx and work upwards and forwards.

Superficial Fascia.—This has the same general characters as the corresponding layer of fascia in other parts of the body. It presents, however, certain peculiarities. It is much more heavily laden with fat—more particularly so in the female. It thickens over the upper and lower margins of the gluteus maximus ; and it is tough and stringy over the ischial tuberosity, where it forms a most efficient cushion upon which the ischium rests while the body is in the sitting posture.

Cutaneous Nerves (Fig. 116).—The cutaneous nerves of the gluteal region are numerous. Some of them are difficult to find, but the small arteries (when well injected) may serve as guides to them; if, however, the subject is obese, many of them are so embedded in the fat, at different levels, that a satisfactory display of the whole series is not easily obtained.

These nerves are derived from the ventral ramus of the last thoracic nerve and, directly or indirectly, from the ventral and dorsal rami of lumbar and sacral nerves ; as in other regions, they ramify and communicate with one another in the superficial fascia on their way to the skin.

The nerves which must be sought for are—

Derived from ventral rami:
- Lateral branch of subcostal. T. 12
- Lateral branch of ilio-hypogastric. L1
- Twigs from posterior branch of lateral cutaneous nerve of thigh. L 2,3
- Twigs from posterior cutaneous nerve of thigh. S 1,2,3
- Perforating cutaneous nerve. S 2,3

Derived from dorsal rami:
- Branches from upper three lumbar nerves.
- Branches from upper three sacral nerves.

Before the dissector attempts to expose the nerves, he must consider their position and direction carefully (Fig. 116).

The *lateral cutaneous branch of the subcostal nerve* (twelfth thoracic) pierces the deep fascia immediately in front of the

tubercle of the iliac crest, and descends in the gluteal region as far as the greater trochanter.

The *lateral cutaneous branch of the ilio-hypogastric nerve* (L. 1) pierces the deep fascia behind the tubercle of the crest, and descends to a like level.

The *posterior branch of the lateral cutaneous nerve* (L. 2, 3) has already been found. It pierces the deep fascia about two inches below the anterior superior iliac spine, and inclines downwards and backwards, sending branches into the gluteal region (p. 201).

Two or three *gluteal branches of the posterior cutaneous nerve* (S. 1, 2, 3) pierce the deep fascia at the middle third of the lower border of the gluteus maximus, and run upwards in the lower part of the gluteal region.

The *perforating cutaneous nerve* (S. 2, 3) arises in the pelvis. It perforates the sacro-tuberous ligament, the gluteus maximus muscle and the deep fascia, appears in the superficial fascia about midway between the coccyx and the ischial tuberosity, and runs laterally in the lower part of the gluteal region.

The *branches from the upper three lumbar dorsal rami* pierce the deep fascia a little above the iliac crest, a little behind its highest point; they descend in the gluteal region almost to the fold of the buttock—crossing and communicating with one another as they descend.

The *branches of the upper three sacral dorsal rami* pierce the deep fascia between the posterior superior iliac spine and the coccyx—about an inch apart—and supply the skin of the adjoining medial part of the gluteal region.

Dissection.—Seek first for the branches of the *sacral nerves*. Reflect the superficial fascia laterally from the median plane between the posterior superior iliac spine and the tip of the coccyx, and secure the nerves as they pierce the deep fascia.

Seek next for the branches of the *lumbar nerves*. Reflect a thin layer of the superficial fascia downwards from the iliac crest, and secure twigs of the lumbar nerves as they come up through the deeper layer of the fascia. These twigs will lead to the trunks of the nerves at the iliac crest ; and the trunks can then be traced and other branches secured. Find the *branches of the ilio-hypogastric* and *subcostal nerves* in the same way.

If the perineum has been dissected, the *perforating cutaneous nerve* may be found *in situ*. If not, seek it between the coccyx and the ischial tuberosity.

The *branches of the posterior cutaneous nerve* of the thigh have now to be displayed. Cut through the superficial fascia along the

lower border of the gluteus maximus. Do so very carefully, for, if you cut the deep fascia also, you are apt to cut the trunk of the posterior cutaneous nerve itself as it escapes from under cover of the gluteus maximus. As soon as the deep fascia is exposed, turn the superficial fascia upwards, and look for the branches as they curve upwards round the lower border of the gluteus maximus about its middle third.

After the cutaneous nerves have been demonstrated, remove the superficial fascia from the whole of the gluteal region in order that the deep fascia may be examined.

Deep Fascia.—The deep fascia now exposed differs in character in the anterior and posterior parts of its extent. In front of the gluteus maximus, where the fascia lies over the anterior part of the gluteus medius, it is dense and opaque and is pearly white in colour—in marked contrast with the deep fascia over the gluteus maximus itself, which is thin and transparent. When the dense portion reaches the anterior border of the gluteus maximus it splits into two lamellæ which enclose the muscle between them. Both lamellæ give origin to some of its fibres, and they send their septa into the muscle to divide it into coarse bundles.

Dissection.—Follow the branches of the posterior cutaneous nerve of the thigh to the trunk of that nerve at the lower border of the gluteus maximus; when the trunk of the nerve is secured, proceed to clean the gluteus maximus—a difficult process, owing to the septa of deep fascia.

The dissector of the *right* limb begins at the upper border of the muscle and works downwards; the dissector of the *left* limb works upwards from the lower border.

Do not remove the thick, opaque fascia which covers the insertion of the muscle.

Keep clearly in mind the rules which have been laid down regarding the cleaning of a muscle:—(1) Make the fibres as tense as possible by rotating the limb; (2) define the borders of the muscle carefully; (3) cut in the direction of the muscular fibres.

As the upper border of the muscle is defined, note the connexion of the fascia with the layer on the deep surface of the muscle and with the fascia on the gluteus medius.

Gluteus Maximus.—The gluteus maximus is a powerful muscle which arises from:—(1) the rough, upper part of the area of the ilium behind the posterior gluteal line; (2) the back of the sacrum and coccyx; and (3) the sacro-tuberous ligament.

From this extensive origin, the fasciculi of the muscle proceed obliquely downwards and forwards towards the upper part of the shaft of the femur; but only a portion of

the muscle is inserted into the bone. Three-quarters of it is inserted into the ilio-tibial tract; only the lower deep quarter is inserted into the gluteal tuberosity. As the upper part approaches its insertion, it becomes aponeurotic; and

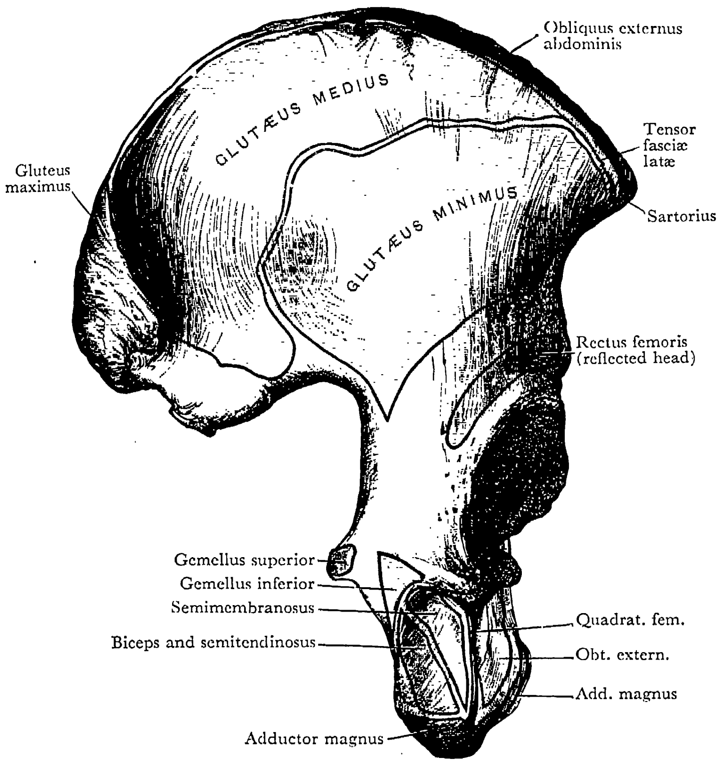


FIG. 117.—Muscle Attachments on dorsal aspect of Hip-Bone.

this sudden thinning of the muscle accounts for the hollow of the hip behind the greater trochanter. It has been noted already that the lower border of the muscle does not correspond to the fold of the buttock but crosses it obliquely.

Three *synovial bursæ* underlie the muscle:—(1) A multilocular bursa separates its lower edge from the tendons that arise from the ischial tuberosity, *i.e.*, the origin of the hamstrings; it is usually difficult to define it, owing to the small

size of its loculi and the stringiness of the fibrous tissue between them. (2) A large bursa separates the aponeurotic part from the greater trochanter; and (3) another large bursa separates the aponeurotic part from the upper part of the vastus lateralis.

The gluteus maximus is supplied by the *inferior gluteal nerve*. It is the chief extensor of the thigh at the hip joint and comes powerfully into action to straighten the lower limb on the trunk, or the trunk on the lower limb, in the act of rising from the stooping and squatting positions, and in walking, running and climbing.

The next dissection is the reflexion of the gluteus maximus, and there are two methods of doing this. The first method described below is the one that should be adopted by students who are dissecting the Lower Limb for the first time.

Dissection.—As the gluteus maximus is reflected, be careful not to injure the structures which lie closely subjacent to it. The nerves most liable to injury are the *posterior cutaneous nerve* of the thigh, already secured (see p. 232), and the *perforating cutaneous nerve*, which is very liable to injury when the fibres of the gluteus maximus are being raised from the *sacro-tuberous ligament*. That ligament itself is liable to be cut if it is not identified before the medial part of the muscle is reflected.

Cut through the muscle from (1) its upper border two finger-breadths above the greater trochanter to (2) the lower border an inch medial to its insertion into the femur.

To facilitate this procedure pass two fingers deep to the muscle (from upper or lower border, whichever is the more convenient), separating it from subjacent structures as the cut is made.

When the muscle is divided, reflect the lateral part to its insertion, open the two bursæ deep to the aponeurosis and explore their extent with the finger-tip. The upper of the two is a large loose sac between the aponeurosis and the greater trochanter of the femur; the other lies below it and in front of the part of the muscle inserted into the gluteal ridge of the femur. A slight touch of the knife is sufficient to open it, and the glistening tendon of the vastus externus comes into view.

Then, reflect the medial part of the muscle towards its origin, working close to the deep surface of the muscle to avoid injuring the posterior cutaneous nerve of the thigh; and, as soon as the vessels and nerves which enter the muscle appear, clean and turn them medially with the muscle (removing the veins, if necessary). These vessels and nerves are:—(1) the *superficial branch of the superior gluteal artery*, encountered as the upper part of the muscle is followed towards the ilium; and (2) the *inferior gluteal nerve and artery*, encountered as the lower part is turned towards the tuberosity of the ischium. As the muscle is lifted from the tuberosity, look for the synovial bursa that separates them.

Identify the sacro-tuberous ligament again. The gluteus maximus arises from it and conceals it; but it can be felt

through the muscle as a firm resisting band that stretches upwards and medially from the ischial tuberosity. Detach the gluteus maximus carefully from the ligament. As you do so, secure the perforating cutaneous nerve and divide the coccygeal branches of the inferior gluteal artery, which pierce the ligament to enter the muscle.

The method of dissection suggested above is the one best adapted to avoid injury to the branches of the inferior gluteal nerve; and it gives a view of the structures subjacent to the muscle similar to that obtained by the surgeon operating on the proximal part of the sciatic nerve.

The method of dissection given in the early editions of this Manual was to reflect the muscle from its origin. That method also gives an excellent display of the subjacent structures, from a purely anatomical point of view, and the student who is dissecting the gluteal region for the second time might employ it with advantage.

Alternative Dissection.—Begin by defining the upper and lower borders of the muscle, and then raise it gently from the deeper structures by passing the hand deep to it close to the greater trochanter and working it medially.

On the left side, begin at the posterior part of the ilium and detach the muscle from its origins. When the surface of the ilium from which it springs is cleared, the upper margin of the greater sciatic notch is reached. Proceed now with caution to avoid injury to the superior gluteal vessels. When these are secured, detach the muscle from the sacrum; the piriformis muscle then comes into sight. Now, separate the gluteus maximus from the sacro-tuberous ligament and the coccyx, preserving the nerves but severing the vessels that pierce the ligament and sink into the gluteus maximus.

On the right side, proceed in the reverse direction from the ischial tuberosity to the ilium.

When the muscle has been detached from its origin, pull it laterally, and divide the branches of the superior gluteal vessels that enter it. The *inferior gluteal vessels* and *nerve* come into view as they emerge at the lower border of the piriformis and sink into the gluteus maximus. Clean them. Then, sever the vessels, but cut the branches of the nerve out of the muscle leaving them attached to a small piece of flesh in order that they may be identified later.

Now, throw the whole muscle downwards and laterally, and examine its insertion.

When the reflexion of the muscle is completed, note carefully the positions of the following parts:—(1) the posterior border of the greater trochanter; (2) the gluteal tuberosity of the femur; (3) the tuberosity of the ischium; (4) the sacro-tuberous and sacro-spinous ligaments. Note also the group of flexor or hamstring muscles which descend from the tuberosity into the back of the thigh.

Bony Landmarks under Gluteus Maximus.—The *trochanter major* is situated in the lower and lateral part of the

area exposed. The *gluteal tuberosity* is immediately below it, and receives the lower deep fibres of the gluteus maximus. The *ischial tuberosity* is about three inches medial to the distal part of the trochanter major. Rotate the thigh laterally (*i.e.*, move it so that its anterior surface is turned away from the median plane); the trochanter is then approximated to the tuberosity; and it recedes from the tuberosity when the thigh is rotated medially.

Sacro-Tuberous Ligament.—This is a long, strong band that extends upwards and medially from the tuberosity of the ischium to the margins of the sacrum and coccyx, and to the posterior iliac spines, inferior and superior. The inferior or medial border of the ligament forms the posterior boundary of the perineum, which may already have been explored by the dissector of the Abdomen, Its upper or lateral margin forms the posterior boundary of two openings called the greater and lesser sciatic foramina, which are separated from each other by the sacro-spinous ligament.

Sacro-Spinous Ligament.—The sacro-spinous ligament is a short, thick triangular band that extends medially from the spine of the ischium to the last piece of the sacrum and the first piece of the coccyx; its medial part is hidden under cover of the sacro-tuberous ligament; but its lateral part can be felt by the finger-tip placed about one inch above the upper border of the tuberosity of the ischium.

On the second day after the body is turned on its face the dissector must examine the muscles, vessels and nerves which lie directly subjacent to the gluteus maximus, and also the structures situated in a deeper plane.

Before the work is begun, obtain a pelvis with the ligaments *in situ*; note the connexions of the sacro-tuberous and sacro-spinous ligaments, and the position of the sciatic foramina.

Sciatic Foramina.—The **greater sciatic foramen** is the upper of the two. It is bounded by the greater sciatic notch of the hip-bone and by both the ligaments; and it transmits the piriformis muscle with the superior gluteal nerve and vessels *above* it, and the inferior gluteal nerve and vessels, the sciatic nerve and other nerves and vessels *below* it.

The **lesser sciatic foramen** is bounded by the lesser sciatic notch of the hip-bone and by both the ligaments; and it transmits the tendon of the obturator internus muscle.

The nerve to obturator internus, the pudendal nerve and the internal pudendal vessels emerge by the great sciatic foramen below the piriformis and disappear immediately into the lesser foramen.

All these structures, as well as other muscles, vessels and nerves, have to be cleaned and examined. The second day's

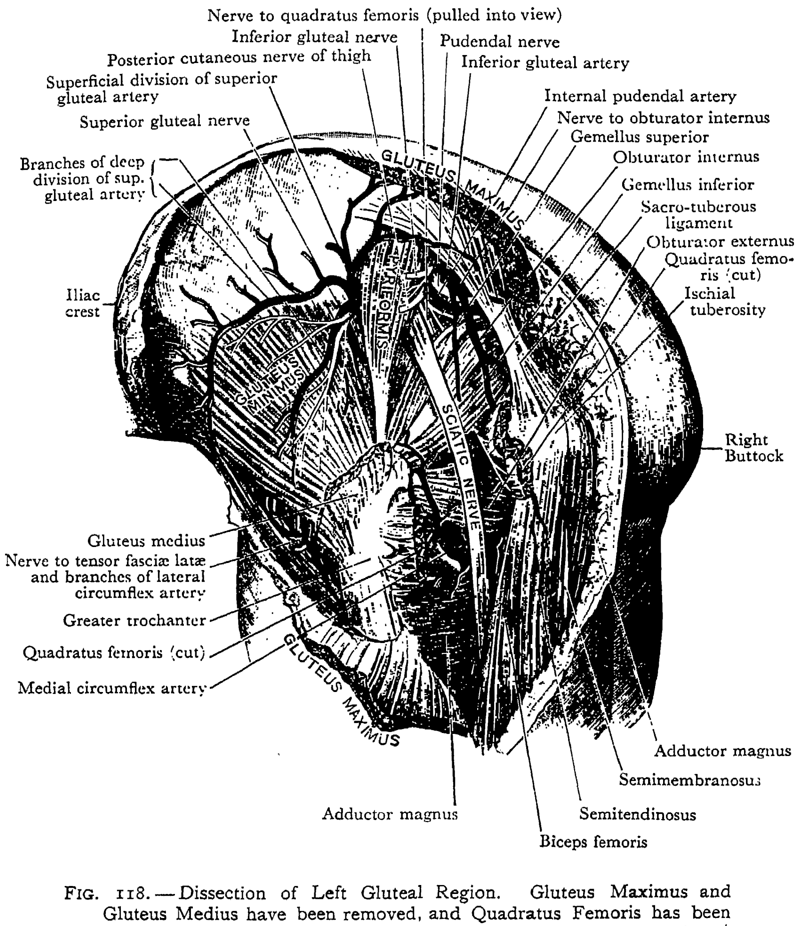


FIG. 118.—Dissection of Left Gluteal Region. Gluteus Maximus and Gluteus Medius have been removed, and Quadratus Femoris has been reflected. In the specimen, the inferior gluteal artery was medial to the internal pudendal instead of lateral to it.

dissection is therefore extensive and complicated, and must be undertaken in a regular and definite manner.

Dissection.—Begin with the *superficial branches of the superior gluteal artery*. They enter the upper part of the gluteus maximus ; follow them to the point where they emerge through the cleft between the gluteus medius and the upper border of the piriformis muscle. Clean the *piriformis* from the greater sciatic foramen to the greater trochanter. Then, clean the *posterior cutaneous nerve of the thigh*, following it upwards to the lower border of the piriformis. Secure its *perineal branch*, which passes below the ischial tuberosity towards the perineum.

Follow the *inferior gluteal vessels* and *nerve* upwards to the lower border of the piriformis.

Flex the knee, and keep it flexed by supporting the leg on a large block. That relaxes the hamstring muscles and the *sciatic nerve*, which is the next structure to be cleaned. It is the thick, firm, white cord that emerges below the piriformis. Cut its fascial covering at the level of the top of the greater trochanter. Insert the handle of the knife, and run it upwards, along the *lateral border* of the nerve, to the lower border of the piriformis, and downwards as far as possible. Clean the fascia from the back of the nerve, and secure the branches to the hamstring muscles that spring from its *medial border* about the level of the ischial tuberosity. They will be followed to the muscles later ; meanwhile, note and preserve the branches of the medial circumflex femoral artery which pass to these muscles with their nerves.

Next, pull the upper part of the sciatic nerve laterally ; look for a slender nerve—the *nerve to the quadratus femoris*—and trace it downwards till it disappears in front of a slip of muscle called the superior gemellus. About a finger's breadth medial to the sciatic nerve, look for the *nerve to the obturator internus*, the *internal pudendal vessels* and the *pudendal nerve*. Clean and preserve the artery and the nerves, but remove the veins.

Now, proceed to clean and examine the muscles that are in front of (*i.e.*, deep to) the sciatic nerve. First, the *tendon of the obturator internus* passing from the lesser sciatic foramen to the greater trochanter, with a fleshy slip along each border—the *superior* and *inferior gemellus*. Below that, the quadrilateral sheet—*quadratus femoris*—extending from the ischial tuberosity to the back of the greater trochanter ; and, below the quadratus, the upper border of the *adductor magnus*. Clean the *transverse branch of the medial circumflex artery*, which emerges between the quadratus and adductor magnus ; and look for a small artery, called the *first perforating*, as it pierces the adductor magnus at the medial border of the gluteal tuberosity.

After the muscles are cleaned, divide the tendon of the obturator internus about a finger's breadth from the lesser sciatic notch. Raise the medial part of the tendon, turn it backwards to find the bursa between it and the floor of the notch ; note the grooved character of the deep surface of the tendon.

Turn next to the hamstring muscles, which spring from the tuberosity of the ischium ; separate the common tendon of the biceps femoris and the semitendinosus from the flattened

tendon of the semimembranosus, which lies immediately subjacent. Then, pull the hamstrings laterally and display the origin of the adductor magnus from the tuberosity.

Parts under Cover of the Gluteus Maximus.—Four groups of structures lie under cover of the gluteus maximus, viz., bursæ, muscles, vessels, nerves.

With the exception of the bursæ, which have already been examined (see p. 233), they have all been mentioned in the foregoing dissection instructions.

Inferior Gluteal Nerve and Vessels.—The **inferior gluteal nerve** (L. 5, S. 1, 2), the nerve of supply to the gluteus maximus, springs from the sacral plexus, and enters the gluteal region through the lower part of the greater sciatic foramen. It divides into two or three branches; and, when the gluteus maximus was reflected, these were seen breaking up into numerous twigs which entered its deep surface in an irregular line between the upper two-thirds and lower third of the muscle. As it emerges from the pelvis it is accompanied by the *posterior cutaneous nerve of the thigh*, which descends to the thigh on the surface of the sciatic nerve; it will be described when the back of the thigh is dissected.

The **inferior gluteal artery**, a branch of the internal iliac artery, issues from the pelvis with the nerve, descends with the sciatic nerve and is continued with the posterior cutaneous nerve to the back of the thigh as a fine cutaneous artery. It supplies large *muscular* branches to the gluteus maximus, cutaneous branches to the buttock and the back of the thigh, and the *companion artery of the sciatic nerve*—a very slender artery that accompanies the nerve for some distance, and then sinks into its substance.

Sciatic Nerve (L. 4, 5, S. 1, 2, 3).—The sciatic nerve—the thickest nerve in the body—is a terminal branch of the sacral plexus, and enters the gluteal region through the lower part of the great sciatic foramen. At first it has the form of a flattened band, but soon it becomes oval or round.

The sciatic nerve traverses the gluteal region in the interval between the greater trochanter of the femur and the tuberosity of the ischium, enclosed in a sheath of fascia; it usually ends half-way down the back of the thigh by dividing into two large branches. These divisions of the sciatic nerve are known as the *lateral* and *medial popliteal nerves* from their relative position in the popliteal fossa, and also as the

common peroneal and *tibial nerves* from their distribution in the leg and their relation to its bones.

In the gluteal region, it is under cover of the gluteus maximus, and lies, from above downwards, on (1) the ischium and the nerve to the quadratus femoris, (2) the tendon of the obturator internus with the two gemelli muscles, (3) the

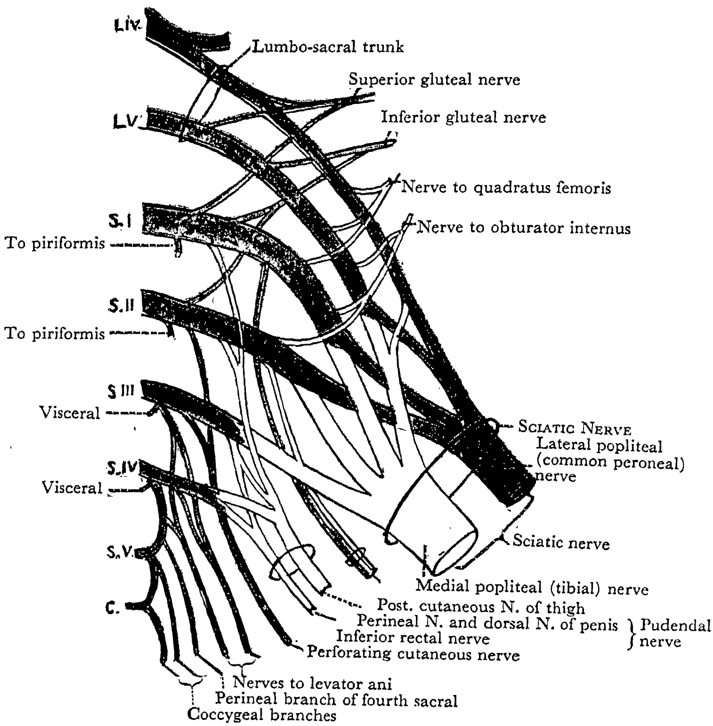


FIG. 119.—Diagram of Sacral Plexus.

Ventral offsets, yellow; dorsal offsets, green. For the principle of the formation and distribution of the plexus, see p. 49, and cf. the arrangement of the brachial plexus, Fig. 18, p. 48. For the lumbar part of the lumbosacral plexus, see Fig. 103, p. 201.

quadratus femoris. As it enters the thigh, it lies on the adductor magnus. The nerves to one or more of the hamstring muscles issue from the medial side of the main trunk at the level of the ischial tuberosity, or a little lower down.

The level of division of the sciatic nerve is variable and it sometimes splits into the lateral and medial popliteal nerves before it leaves the pelvis ; the medial popliteal nerve then emerges from the pelvis below the piriformis, but the lateral nerve pierces the muscle.

Internal Pudendal Artery, Pudendal Nerve and Nerve to Obturator Internus.—These structures run only a very small part of their course in the medial part of the gluteal region where they have been exposed by the reflexion of the gluteus maximus. They emerge from the pelvis through the greater sciatic foramen and cross the spine of the ischium and the sacro-spinous ligament; they then enter the lesser sciatic foramen and pass out of view. The *nerve to the obturator internus* lies on the base of the ischial spine, and furnishes a twig to the gemellus superior. The *internal pudendal artery*, with a companion vein on each side, crosses the tip of the spine. The *pudendal nerve* lies on the sacro-spinous ligament, close to the ischial spine.

SMALL LATERAL ROTATOR MUSCLES OF THIGH.—Under this heading are included the piriformis, the obturator internus and the two gemelli, the quadratus femoris, and the obturator externus. They are not all completely exposed by reflexion of the gluteus maximus. The piriformis and obturator internus emerge from the pelvis, and only part of the obturator externus, which lies deep (anterior) to the quadratus femoris, is seen from behind when that muscle has been reflected. But they are all inserted into the greater trochanter, and they are related to the back of the hip joint.

Piriformis.—The piriformis muscle arises within the pelvis, chiefly from the middle three pieces of the sacrum. After it has passed through the greater sciatic foramen, its fleshy belly rapidly tapers and it ends in a rounded tendon which passes superficial to the tendon of the obturator internus, and is inserted into the upper border of the greater trochanter (Fig. 113). It is closely adherent to the subjacent obturator tendon for some distance. The piriformis is supplied in the pelvis by branches from the *first* and *second sacral nerves*.

Obturator Internus (Fig. 118).—This muscle has a large, fan-shaped fleshy belly which arises, within the pelvis, from the side wall and front wall of the pelvic cavity. Its fibres converge on the *tendon*, which issues through the lesser sciatic foramen, bends at a right angle, and runs laterally across the back of the hip joint to be inserted into the medial surface of

the greater trochanter (Figs. 113, 134). The deep surface of the tendon is divided into four or five portions by longitudinal grooves, and is separated by a *bursa* from the floor of the lesser sciatic notch, which is correspondingly ridged.

Gemelli.—The *gemellus superior* arises from the upper margin of the lesser sciatic notch. Its fibres run along the upper border of the tendon of the obturator internus, and are inserted obliquely into it. The *gemellus inferior* arises from the lower margin of the lesser sciatic notch, and is inserted into the lower border of the obturator tendon in a similar manner.

Close to their origins, the gemelli meet under cover of the obturator tendon, and form a fleshy bed on which the tendon lies; near the trochanter their fibres overlap the obturator tendon, and tend to cover its superficial surface.

Quadratus Femoris.—The quadratus femoris lies between the gemellus inferior and the adductor magnus. It arises from the lateral border of the ischial tuberosity, and proceeds horizontally to gain insertion into the back of the greater trochanter and the adjoining part of the shaft of the femur (Fig. 134).

> *Dissection.*—Push the sciatic nerve aside as it emerges from the pelvis and secure the *nerve to the quadratus femoris*, which is hidden under cover of it. Cut the gemelli at the lateral side of the nerve to quadratus, and trace the nerve downwards to the deep (anterior) surface of the quadratus femoris; find its branches to the hip joint and gemellus inferior. Then, divide the quadratus femoris midway between its origin and insertion, throw the two parts aside, and clean the structures that are under cover of it—the lower part of the back of the *capsule of the hip joint*, the tendon of *obturator externus*, the *medial circumflex artery*, and the insertion of the *ilio-psoas* muscle.

Nerve to Quadratus Femoris.—This nerve arises from the sacral plexus, and escapes from the pelvis through the lower part of the greater sciatic foramen. It then descends over the ischium and the capsule of the hip joint, under cover of the sciatic nerve, the obturator internus and the gemelli; gives a twig to the hip joint; supplies the inferior gemellus, and sinks into the deep surface of the quadratus femoris to supply it.

Obturator Externus.—The external obturator muscle arises from the front of the pelvis, and its origin will be examined when the medial side of the thigh is dissected. It winds backwards below the hip joint, and its tendon is seen here passing obliquely upwards and laterally on the back of the neck of the femur to be inserted into the trochanteric fossa.

Medial Circumflex Artery.—This artery arises from the profunda in the femoral triangle. It passes backwards among the muscles of the medial side of the thigh, and ends near the upper border of the adductor magnus by dividing into ascending and transverse branches (see p. 267). The *ascending branch* runs obliquely upwards and laterally towards the trochanteric fossa, giving off muscular twigs. The *transverse branch* passes backwards, and then, curving downwards, it breaks up into branches which enter the hamstring muscles. It anastomoses with the terminal twig of the transverse branch of the lateral circumflex artery, which, in a well-injected subject, will be noticed appearing from amidst the fibres of the upper part of the vastus lateralis. An arterial circle is thus formed around the upper part of the femur; it communicates proximally with the inferior gluteal artery and distally with the first perforating artery. This series of inosculations is sometimes spoken of as the *crucial anastomosis* of the thigh.

The dissector has now examined all the structures which lie below the level of the piriformis in the gluteal region. He should, in the next place, turn his attention to that portion of the dissection which is above the level of that muscle. There he will find several structures which lie in close relation to the ilium. These are the gluteus medius and minimus, and the tensor fasciæ latæ, together with the blood-vessels and nerve which supply them, viz., the superior gluteal vessels and nerve.

The posterior part of the gluteus medius was covered by the gluteus maximus; its anterior border is overlapped by the tensor fasciæ latæ; the rest of it is invested by the dense fascial layer already referred to, and is the fleshy substance felt through the skin and fasciae below the iliac crest on the side of the hip in the living body.

***Dissection.*—Remove the fascia from the superficial surface of the gluteus medius and pull the tensor fasciæ latæ forward.**

Gluteus Medius.—This wide, thick muscle arises from the large area between the middle gluteal line and the iliac crest (Fig. 117, p. 233). The fibres converge to form a flattened band, partly fleshy and partly tendinous, which is inserted into the postero-superior angle of the greater trochanter and the oblique ridge on its lateral surface. A small *bursa* separates the tendon from the anterior part of the lateral surface of the trochanter.

The gluteus medius muscle is supplied by the *superior gluteal nerve*. As a whole, the muscle is an abductor of the thigh, but its anterior fibres can rotate the thigh medially.

***Dissection.*—The gluteus medius must now be reflected. Keep the tensor fasciæ pulled well forward. Insert the fingers between the posterior borders of the gluteus medius and minimus, and separate the muscles, from behind forwards, to their anterior**

margins. Then, divide the medius two inches above the trochanter major, and reflect the two parts towards their attachments. As the lower part of the muscle is reflected, look for the small bursa that lies between it and the trochanter. When the upper part of the muscle is raised, the branches of the superior gluteal vessels and nerve, will be exposed ; clean them and preserve them, except the twigs which enter the gluteus medius and interfere with its reflexion. As you follow the branches of the artery and nerve, clean the surface of the gluteus minimus.

Superior Gluteal Nerve.—This nerve (L. 4, 5 ; S. 1) arises from the sacral plexus, and escapes from the pelvis through the upper part of the greater sciatic foramen. It then turns forward, between the gluteus medius and minimus, and immediately divides into two or more branches. The upper branch or branches sink into the gluteus medius. The lowest branch crosses the middle of the gluteus minimus; after giving branches to both the gluteus medius and minimus, it passes between their anterior borders and ends in the tensor fasciæ latæ opposite the greater trochanter.

Superior Gluteal Vessels.—The **superior gluteal artery** is a large vessel which springs from the internal iliac artery and escapes from the pelvis with the nerve and the vein; immediately after its exit, it divides into a superficial and a deep division.

The *superficial division* has been already seen during the reflexion of the gluteus maximus. Its branches are distributed to the deep surface of that muscle.

The *deep division* bifurcates, close to its origin, into a superior and an inferior branch. The inferior branch accompanies the lowest branch of the nerve. The superior branch follows the upper border of the gluteus minimus close to the middle gluteal line of the ilium.

Gluteus Minimus.—This also is a thick, wide muscle; it arises from the broad area of the ilium between the middle and inferior gluteal lines (Fig. 117, p. 233). The muscular fibres pass gradually into an aponeurotic tendon which covers the superficial surface of the distal part of the muscle and narrows to be inserted into the lower and lateral part of the front of the greater trochanter (Fig. 113, p. 223). It is intimately connected, near its insertion, with the capsule of the hip joint; and it is separated from the upper and anterior part of the trochanter by a small *bursa*.

The gluteus minimus is supplied by the *superior gluteal nerve*. Its actions are the same as those of the gluteus medius.

Dissection.—Detach the gluteus minimus from its origin and turn it downwards, separating it from the capsule of the hip joint. Open the bursa, and examine its extent.

Parts under Cover of the Gluteus Minimus.—As the gluteus minimus is reflected three structures are displayed :—(1) part of the capsule of the hip joint ; (2) the reflected tendon of the rectus femoris ; and (3) the bursa between the gluteus minimus and the greater trochanter.

The upper and posterior parts of the **capsule of the hip joint** are now exposed. Note that the capsule is loosely attached to the back and upper part of the neck of the femur, about a finger's breadth medial to the trochanter, but firmly attached to the acetabular rim. Many of the fibres of the posterior part of the capsule run circularly around the neck of the femur and are named the *zona orbicularis* (see p. 275).

The **reflected tendon of the rectus femoris** is attached to the floor of a groove situated immediately above the margin of the acetabulum, and is there embedded under the superficial fibres of the capsule (p. 224). To expose it, cut through these fibres parallel with the direction of the tendon.

POPLITEAL FOSSA

The dissection of the popliteal fossa should be carried out before the back of the thigh is disturbed, in order that its contents may be examined before the medial and lateral boundaries of its upper portion are displaced. The dissection should therefore begin on the *third day* after the body has been turned.

Surface-Anatomy.—The region of the popliteal fossa is behind the knee, opposite the lower third of the femur, the knee joint and the upper part of the tibia. It appears as a hollow when the knee joint is flexed, but it bulges slightly when the joint is fully extended. The bony points and the tendons in this region are identified more easily in the living body than in the dead.

In the sides of the area, about the middle of its length, the **condyles of the femur** are easily distinguished, and, below them, the **condyles of the tibia.** But the best landmark in this region is the **head of the fibula.** It is below the posterior part of the lateral condyle of the tibia, and forms a well-

marked prominence far back on the lateral side of the limb, at the same level as the tuberosity of the tibia.

The thick cord that descends to the head of the fibula is the tendon of insertion of the **biceps femoris,** which is most easily identified when the joint is flexed. Having identified it, examine it with the knee alternately extended and flexed. When the knee is straight, the tendon lies on the posterior part of the lateral surface of the lateral condyle of the femur, and produces a slight, longitudinal elevation far back on the lateral side of the knee. Place your finger on the back of the knee, close to the medial side of that elevation, and press : the bone felt is the back of the lateral condyle. Move your finger to and fro sideways : the large nerve felt is the **lateral popliteal.** Flex the knee slowly and watch the tendon of the biceps : it slips off the lateral condyle and comes more fully into the lateral boundary of the popliteal fossa ; and it is now much more easily seen than when the knee was straight, for the tendon now forms a ridge, on the lateral side of the limb, bounded anteriorly by a distinct groove. In a thin limb, the anterior boundary of that groove is another ridge, so well marked that it is sometimes mistaken for the ridge made by the tendon of the biceps. It is produced by the posterior part of the **ilio-tibial tract** ; this part of the tract is thick and very strong, and can be traced down to a small tubercle on the front of the lateral condyle of the tibia. With the knee still flexed, press your finger into the interval between the head of the fibula and the femoral condyle ; the **lateral ligament of the knee joint** is felt there as a rounded, cord-like band. Then, place your finger on the back of the head of the fibula, push the soft parts medially, and move the finger sideways to feel the **lateral popliteal nerve** again.

On the medial side also, the tendons are palpated more easily when the knee is flexed. The rounded tendon of the **semitendinosus** is felt near the surface, posteriorly ; and the **gracilis** is felt medially, but is obscured to some extent by the **sartorius,** which lies immediately in front of it, and even overlaps it. The **semimembranosus** tendon, thicker than either the gracilis or the semitendinosus, is deep to both of them, but can be felt if firm pressure is used.

In the upper part of the popliteal region, the muscles of the two sides are fairly close together ; the distal part of the belly of the semimembranosus is thick, and it makes a periodic

bulging near the middle line of the limb as the muscle contracts and relaxes when a person is walking. In the middle of the region, the pulsations of the **popliteal artery** are felt when deep pressure is made. In the lower part, the two heads of the **gastrocnemius** muscle form two rounded cushions that merge inferiorly into the calf.

Above the popliteal region, the back of the thigh is smooth and rounded ; but, in a thin person, the outlines of the bellies of the hamstring muscles may be seen faintly.

Dissection.—Reflexion of the Skin.—Place a block under the knee to support the limb and to make the boundaries of the popliteal fossa tense. *Incisions*—(1) A vertical incision along the middle line of the limb in the lower third of the thigh and upper fourth of the leg. (2) Transverse incisions at the ends of the vertical incision, each extending half-way round the limb (21, 22 of Fig. 115). Separate the two flaps of skin from the superficial fascia and turn them aside.

Superficial Fascia and its Contents.—The superficial fascia of the popliteal region presents no peculiar features, and, as a rule, it contains only a moderate amount of fat, amidst which a vein and three cutaneous nerves are to be sought.

Dissection.—Look first for the *small saphenous vein* ascending from the calf and piercing the deep fascia over the distal part of the fossa. As the upper part of the vein is being cleaned, secure the terminal part of the *posterior cutaneous nerve of the thigh*, which runs alongside the vein. At a higher level, in the middle line of the popliteal area, one or more twigs from the posterior cutaneous nerve may be found piercing the deep fascia.

The posterior branch of the *medial cutaneous nerve* of the thigh has been found already, on the medial side of the thigh (Fig. 116). Follow it now, as it descends to the back of the calf. The *sural communicating nerve* (a branch of the lateral popliteal) may be found at the lower and lateral part of the popliteal area as it pierces the deep fascia (Fig. 116). Sometimes, however, the nerve pierces the deep fascia much lower down, and will not be found until the back of the leg is dissected. After the structures mentioned have been secured and cleaned, remove the remains of the superficial fascia, but avoid injury to the deep fascia.

Popliteal Fascia.—The deep fascia of the popliteal region is thin, but it possesses considerable strength owing to the transverse fibres which are interwoven amidst its longitudinal fibres. It is firmly attached, on each side, to the tendons of the muscles which bound the popliteal fossa.

Boundaries of Popliteal Fossa.—The fossa is bounded above and laterally by the *biceps femoris muscle* ; above and

medially by the *semitendinosus* and the *semimembranosus muscles*, supplemented by the *gracilis*, the *sartorius* and the tendon of the *adductor magnus*—the semitendinosus lying on the back of the semimembranosus, while the other muscles are farther forward. The lower part of the fossa is bounded by the two heads of the *gastrocnemius* as they converge (Fig. 120), and the lateral head is supplemented by a small muscle called the *plantaris*, which lies along its medial border.

Popliteal Fossa seen in Section through the Frozen Knee.—The arrangement of its boundaries makes the space behind the knee joint which is brought into view by dissection appear to be diamond-shaped; but this appearance differs widely from the condition observed when transverse sections are made through this part of the frozen limb (Fig. 122). Before the skin and fasciæ are removed, all the parts are tightly braced together, and the popliteal fossa is represented merely by a small intermuscular interval between the distal parts of the hamstring muscles. The fossa in this condition is rather under an inch wide at its broadest part. The popliteal artery, therefore, is covered by muscles, except a very small part just above the knee joint.

The dissector will now clean the upper boundaries of the fossa, leaving the lower boundaries to be cleaned at the same time as the contents.

Dissection.—Clean first the upper lateral boundary. Make an incision through the deep fascia along its medial margin; turn the fascia laterally and expose the *biceps femoris*. Clean the muscle and its tendon. Turn next to the upper medial border of the space. Make an incision through the deep fascia along its lateral margin, and reflect the fascia towards the medial side to expose the *semitendinosus* tendon and *semimembranosus* muscle. Follow the tendon of the semitendinosus to the level of the medial condyle of the tibia; then, pull it aside and clean the distal part of the semimembranosus and its tendon. Pull the part of the muscle which lies at the level of the medial condyle of the femur towards the medial side of the knee and display the *semimembranosus bursa*, which lies between the semimembranosus and the medial head of the gastrocnemius. Open the bursa and find whether it communicates with the bursa in front of the gastrocnemius, and whether that bursa communicates with the cavity of the knee joint.

Now, pull the semitendinosus and semimembranosus laterally, and clean the *gracilis*. The *saphenous nerve* emerges between the gracilis and the sartorius, accompanied by an artery; secure the artery and nerve and follow them downwards with the great saphenous vein. Lastly, pull the gracilis medially and clean the distal part of the adductor magnus.

Before the dissector begins to open up the fossa, he should read (with reference to Figs. 120 and 121) the following paragraphs, which deal in a general way with the contents of the fossa.

Contents of Popliteal Fossa.—The principal objects in the fossa are the *lateral* and *medial popliteal nerves* and

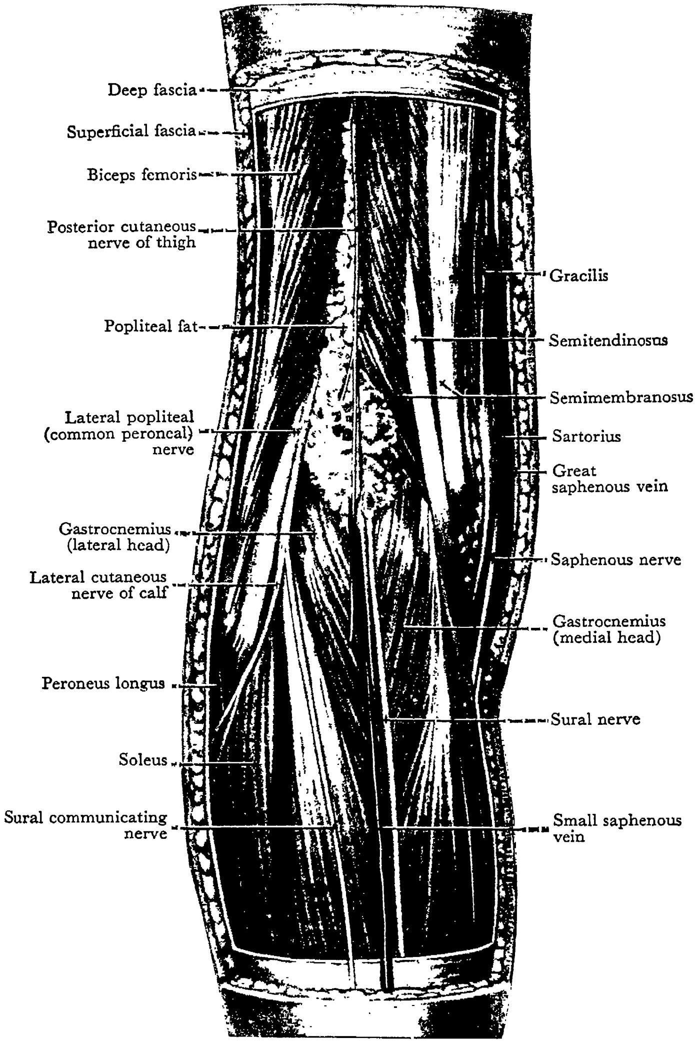


FIG. 120.—Left Popliteal Region after Removal of the Deep Fascia—the Muscles and Fat being left undisturbed.

the *popliteal artery* and *vein*, with their branches and tributaries ; but the most superficial structure, in the upper part of the space, is the *posterior cutaneous nerve of the thigh.* This nerve runs along the middle line, immediately subjacent to

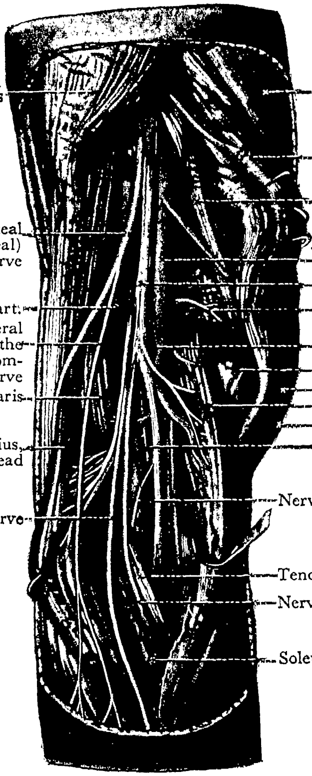


FIG. 121.—Dissection of Left Popliteal Fossa. The upper boundaries have been pulled apart and the aponeurosis to which the two heads of the gastrocnemius are attached has been split and the heads separated. For deeper dissection, see Fig. 123.

the popliteal fascia, until it pierces that fascia in the lower part of the space ; it sends one or two branches through the fascia to the skin.

The medial popliteal nerve is separated from the posterior cutaneous nerve of the thigh by a thin layer of fat, and lies superficial to the popliteal vessels, which are situated in a

much deeper plane, in close contact with each other. The lateral popliteal nerve lies along the upper lateral boundary of the fossa. Both the popliteal nerves give off branches, most of which are easily found, but their articular branches are delicate and are easily destroyed by the dissector who does not exercise care. One of the articular nerves, however, is derived not from a popliteal nerve but from the posterior division of the obturator nerve. It is a slender filament that descends in close apposition to the popliteal artery.

Other important contents of the fossa are *lymph-nodes*, some of which lie relatively superficial, near the point where the small saphenous vein pierces the popliteal fascia, but the majority are deeply placed alongside the popliteal vessels.

The dissector will now open up the fossa and display its contents.

Dissection.—Secure the *posterior cutaneous nerve of the thigh* at the point where it pierces the popliteal fascia, and follow it to the upper angle of the fossa ; then, remove the remains of the popliteal fascia from the upper part of the popliteal area.

Now, pull the posterior cutaneous nerve aside with a hook, and cut through the fat in the upper angle of the fossa till a large nerve—the *medial popliteal*—is exposed. Follow the nerve downwards, and secure its cutaneous, muscular and articular branches. Its cutaneous branch—the *sural nerve*—descends between the two heads of the gastrocnemius. Follow that branch to the distal angle of the fossa. The articular branches are three in number—*superior medial genicular*, *inferior medial genicular* and *middle genicular*. The superior branch arises at or above the upper angle of the fossa, and the other two at lower levels. Follow them as far as possible. The *muscular branches* arise about the middle of the fossa and pass to the two heads of the gastrocnemius, the plantaris, the soleus and the popliteus. Separate the heads of the gastrocnemius and trace these branches to the muscles—except the nerve to the popliteus, which lies deeply and will be followed in a subsequent dissection.

Return to the upper angle of the fossa, and secure the *lateral popliteal* nerve. Follow it to the lateral angle, and, thence, to the back of the head of the fibula, avoiding injury to its branches. Look for its *genicular* branches. They arise high up in the fossa or above the fossa ; the upper one passes out of the fossa above the lateral femoral condyle ; the lower one accompanies the nerve-trunk out of the fossa. Secure the *sural communicating* branch and the *lateral cutaneous nerve of the calf*. They arise from the lateral popliteal near the lateral angle of the fossa (sometimes by a common stem). Follow them downwards.

Next, clean the plantaris and the two heads of the gastrocnemius, dividing the muscular arteries if they are in the way. Separate the plantaris from the lateral head, avoiding injury to the *nerve to the soleus*, which passes between them.

Now, clean the popliteal vessels and their branches and tributaries. Begin by pulling the medial popliteal nerve laterally and clearing away the fat that lies superficial to the vessels. The popliteal vein is encountered first. Look in the groove between the upper part of the artery and the vein for the *genicular branch of the obturator nerve*. It is a mere filament, and easily escapes notice. If you find it, trace it downwards to the back of the knee joint, and upwards into the substance of the adductor magnus.

Then, clean the *popliteal vein*. Not uncommonly, there are accessory venous channels that communicate with the main vein and anastomose with one another around the artery. If they

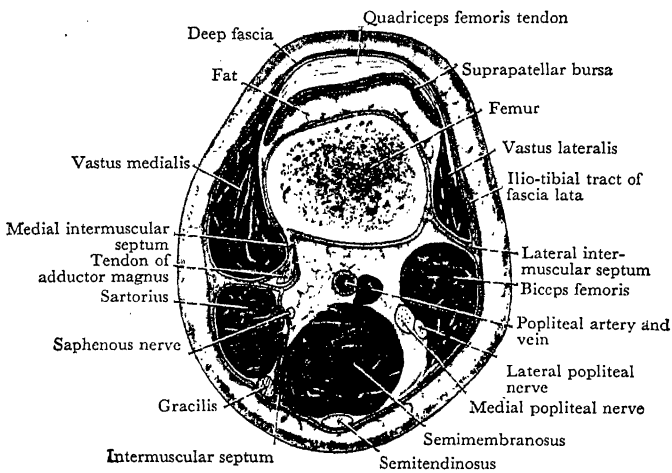


FIG. 122.—Transverse Section through proximal part of Popliteal Region of Thigh.

are present, remove them ; but be careful of the branches of the artery, and preserve the *small saphenous vein*.

Next, clean the *popliteal artery* and its branches. The muscular branches are met with first. Clean them and divide them, noting particularly the large size of the branches that enter each head of the gastrocnemius with its nerve at a well-defined neuro-vascular hilum (p. 12). Now, scrape the fatty tissue from the popliteal surface of the femur with the handle of the knife ; but take care of the articular vessels and nerves. The articular or *genicular arteries* spring from the popliteal artery ; they lie close to the floor of the fossa and are joined by the genicular nerves. They were seen, therefore, when the nerves were traced. Follow the two superior and inferior pairs out of the fossa, and the single, middle artery to the middle of the posterior ligament of the knee joint.

Floor of Popliteal Fossa.—The floor is formed from above downwards by—(1) the popliteal surface of the femur ;

(2) the capsule of the knee joint; and (3) a strong fascia which covers the popliteus muscle.

Medial Popliteal (Tibial) Nerve.—This nerve (L. 4, 5; S. 1, 2, 3) is the larger of the two terminal branches of the sciatic nerve, and begins a little above the popliteal fossa—about the middle of the back of the thigh. It enters the fossa at its upper angle, emerging from under cover of the biceps femoris. It bisects the fossa and is continuous below its distal angle with the *posterior tibial nerve.*

Its superficial position in the fossa has already been remarked. When it enters the fossa, it lies on the lateral side of the popliteal vessels (Fig. 123); at the mid-length of the space, it crosses superficial to them; and in the distal part of the space, it is medial to them. Consequently, the muscular branches, given off in the lower part of the fossa for the lateral head of the gastrocnemius, the plantaris, the soleus, and the popliteus, cross behind the vessels to reach these muscles.

Branches.—They are classified as cutaneous, muscular and articular.

The *sural nerve* is the cutaneous branch. It arises about the middle of the fossa, and runs downwards in the furrow between the two heads of the gastrocnemius into the back of the leg, and thence, along the lateral side of the foot, to the little toe (Fig. 116).

The *muscular branches* supply both heads of the gastrocnemius, the plantaris, the soleus and the popliteus: they come off in the distal part of the fossa. The branch to the soleus passes between the plantaris and the lateral head of the gastrocnemius, and enters the *superficial* surface of the soleus near its upper end. (The soleus receives another motor nerve on its deep surface, p. 314.) The branch to the popliteus also requires special notice. It arises lower down than the others, and, having crossed behind the popliteal artery, it descends over the popliteus muscle, and gains the anterior surface of the muscle by winding round its distal border. This will be seen better when the popliteus muscle is dissected. This little nerve gives branches also to the interosseous membrane and the superior tibio-fibular joint.

The *articular branches* are three in number. They are given off in the upper part of the fossa—sometimes even above the fossa. They accompany the corresponding genicular arteries, and supply the ligaments and synovial membrane

of the knee joint. The *superior medial genicular nerve* runs medially, above the medial condyle of the femur, deep to the muscles. The *middle genicular nerve* pierces the

FIG. 123.—Dissection of Left Popliteal Fossa. The two heads of the gastrocnemius and portions of the semimembranosus and semitendinosus have been removed. For more superficial dissections, see Figs. 120, 121.

middle of the posterior ligament of the knee joint to supply the cruciate ligaments in the interior.

The *inferior medial genicular nerve* is larger than the other two, and more easily found. It runs downwards and medially along the upper border of the popliteus muscle, and then curves forwards below the medial condyle of the tibia, under cover of the medial ligament of the knee.

Lateral Popliteal (Common Peroneal) Nerve.—This nerve (L. 4, 5 ; S. 1, 2) is the smaller of the two terminal divisions of the sciatic nerve. It arises about the middle of the thigh, and terminates at the lateral side of the neck of the fibula, under cover of the peroneus longus muscle, by dividing into two branches named the *musculo-cutaneous* (*superficial peroneal*) *nerve* and the *anterior tibial* (*deep peroneal*) *nerve*. It does not traverse the entire length of the popliteal fossa. It runs downwards and laterally along the medial border of the biceps femoris, and leaves the fossa at its lateral angle, where it crosses the plantaris and the lateral head of the gastrocnemius ; it then passes behind the head of the fibula ; and, finally, it turns forwards to its termination between the lateral side of the neck of the fibula and the peroneus longus. In the fossa, it is covered only by skin and fasciæ, and, in the living limb, it can easily be rolled under the finger where it lies on the fibula.

Branches.—Two cutaneous and three articular branches spring from it, but it gives off no muscular branches, except occasionally the first branch to peroneus longus.

The *cutaneous branches* are the sural communicating nerve and the lateral cutaneous nerve of the calf. They frequently take origin by a common stem.

The *sural* (*peroneal*) *communicating nerve* arises in the upper part of the popliteal fossa, and runs downwards into the calf to join the sural nerve at a varying level.

The *lateral cutaneous nerve of the calf* arises as the lateral popliteal lies on the lateral head of the gastrocnemius. It pierces the deep fascia almost at once, and descends to supply the skin of the lateral and anterior surfaces of the upper part of the leg.

The *articular branches* are the *superior* and *inferior lateral genicular nerves* and the recurrent genicular nerve. The first two accompany the lateral genicular arteries. They are of small size, and it is difficult to find them.

The *recurrent genicular nerve* springs from the termination of the lateral popliteal nerve. It runs upwards to the front of the knee, and will be dissected at a later stage (p. 297).

Popliteal Artery (Figs. 123, 124).—The popliteal artery is the continuation of the femoral artery. It begins behind the femur at the tendinous opening in the adductor magnus ; and it descends to terminate at the distal border of the popliteus

muscle by dividing into the anterior and posterior tibial arteries. The division is hidden from view at present by the upper border of the soleus muscle; but it will be exposed when the leg is dissected.

Relations.—The artery is deeply placed. In the upper part of the fossa, it is under cover of the semimembranosus (Fig. 122). Between the condyles, it is covered by fat, and is crossed from lateral to medial side by the popliteal vein and the medial popliteal nerve. In the lower part of the fossa, it is overlapped by the heads of the gastrocnemius, and is crossed by the plantaris and by the nerves to the lateral head of the gastrocnemius, plantaris, soleus and popliteus. At its termination, it is under cover of the gastrocnemius and the upper border of the soleus.

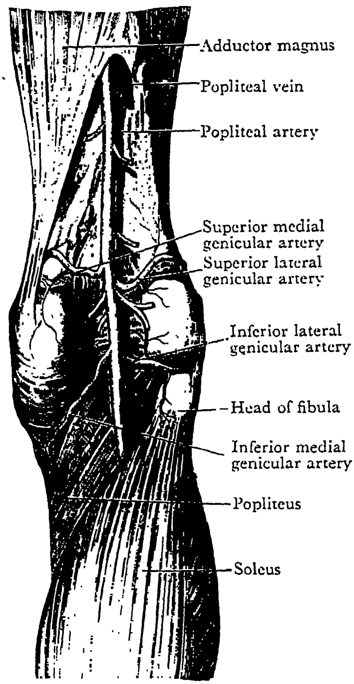


FIG. 124.—Right Popliteal Artery and its Branches.

Throughout its whole course, the popliteal artery rests against the floor of the popliteal fossa. In its proximal part, it is separated from the femur by some fat; between the condyles of the femur, it crosses the capsule of the knee joint; and, in the distal part of the fossa, it is in contact with the fascia of the popliteus muscle.

Branches.—The branches are muscular, cutaneous and articular.

The *muscular branches* are distributed to the hamstring muscles and to the muscles of the calf of the leg.

The *cutaneous branches* are irregular twigs that arise from the muscular branches; the most constant of them accompanies the upper part of the sural nerve.

PLATE XXV

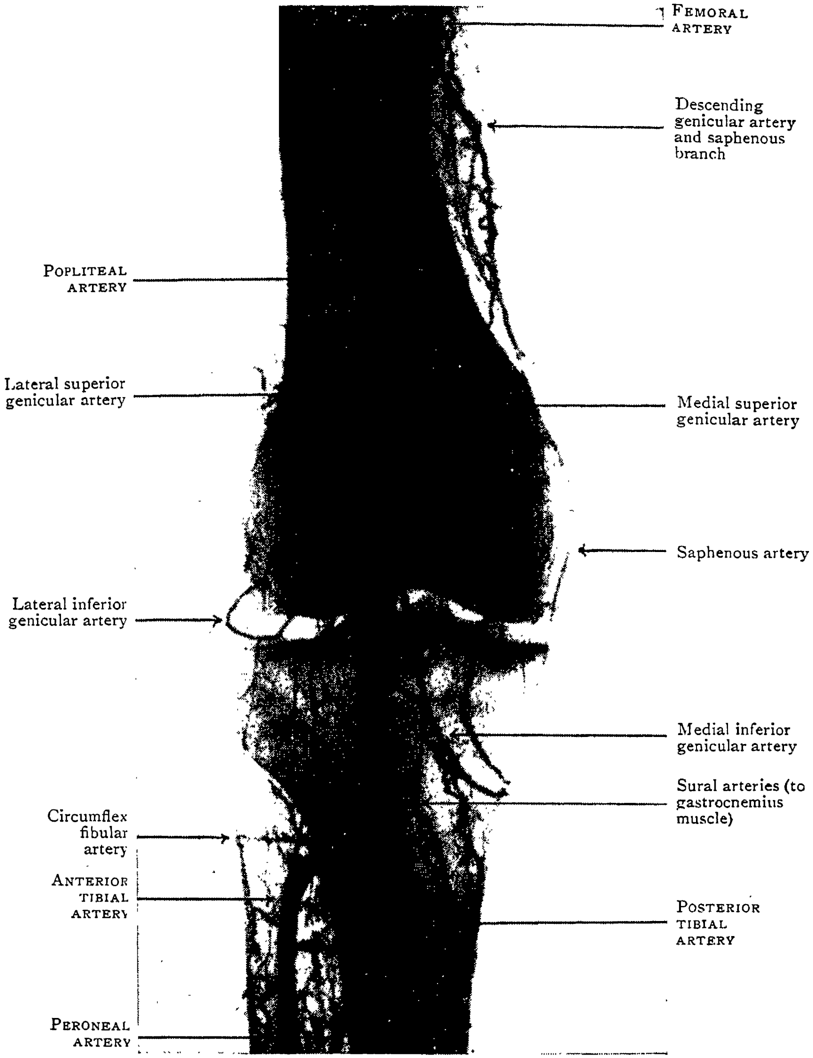


FIG. 125.—Antero-posterior Radiograph of Knee Region after injection of the Arteries with radio-opaque material (from positive print). Cf. Figs. 124, 126, 160.

[*Facing p.* 256

FIG. 126.—Lateral Radiograph of Knee Region after injection of the Arteries with radio-opaque material (from positive print). Cf. Figs. 124, 125, 156.

[*Facing p.* 257

The *articular branches* are the five genicular arteries, distinguishable from the muscular branches because they cling to the floor of the fossa and accompany the genicular nerves.

The two **superior genicular arteries** spring from the main trunk in the interval between the upper parts of the condyles of the femur. The two **inferior genicular arteries** arise opposite the knee joint. The immediate course of these vessels is shown in Fig. 124, and their relation to the anastomosis around the knee joint may be studied in Fig. 160, p. 324, and in Plates XXV and XXVI.

The **middle genicular artery** springs from the popliteal as it lies on the oblique posterior ligament of the knee joint. It pierces that ligament to reach the synovial membrane and the cruciate ligaments in the interior of the joint.

Genicular Branch of the Obturator Nerve.—This slender filament is the continuation of the posterior division of the obturator nerve and usually lies on the posterior surface of the popliteal artery. It enters the popliteal fossa by piercing the distal part of the adductor magnus close to the linea aspera; and it enters the knee joint after passing through the oblique posterior ligament.

Popliteal Vein.—This vessel is formed, near the distal border of the popliteus muscle, by the union of the venæ comitantes of the anterior and posterior tibial arteries. It ascends through the popliteal fossa to the opening in the adductor magnus, where it becomes the femoral vein. It begins at the medial side of the artery and gradually crosses behind it to take up a postero-lateral position; the two vessels are bound together in a fibrous sheath. In addition to tributaries that correspond to branches of the artery, it receives the small saphenous vein. By slitting it open with the scissors the dissector will see that it has three (sometimes four) valves in its interior.

BACK OF THIGH

The dissection of the back of the thigh must be completed on the fifth day.

***Dissection.*—Reflexion of Skin.—Make a vertical incision through the middle of the belt of skin which still covers the region (Fig. 115, 20), and reflect the two flaps.**

Superficial Fascia and Cutaneous Nerves. — The superficial fascia of the back of the thigh presents no features of special interest, but in it there ramify cutaneous nerves derived from three sources:—(1) from the *posterior cutaneous nerve of the thigh*, (2) from the *lateral cutaneous nerve of the*

thigh, and (3) from the *posterior branch of the medial cutaneous nerve.*

Dissection.—Look for the branches of the *posterior cutaneous nerve of the thigh* along the middle of the back of the thigh; they vary in number, and they pierce the deep fascia at varying levels (Fig. 116, p. 229). To facilitate the search for them, find the trunk of the nerve in the gluteal region, and pull gently on it.

Follow the branches of the *lateral* and *medial cutaneous nerves* from the portions of those nerves which were displayed when the front of the thigh was dissected.

Remove the remains of the superficial fascia to display the deep fascia.

Deep Fascia.—The deep fascia is thin but fairly strong. It consists of longitudinal fibres mingled with transverse fibres.

Dissection.—Divide the deep fascia by a longitudinal incision taking care not to injure the *posterior cutaneous nerve of the thigh*, which lies immediately under cover of the fascia. Turn the two flaps of deep fascia aside, and clean the posterior cutaneous nerve.

Then, clean the posterior surfaces of the *hamstring muscles.* Having done so, follow the *sciatic nerve* from the buttock downwards, and trace its branches into the hamstring muscles and adductor magnus; special care should be taken to identify the nerve of supply to the short head of the biceps which, unlike the others, arises from the lateral side of the main nerve. At the same time, note the muscular arteries that run with or near the nerves; they come from the *perforating branches* of the profunda artery.

Now, clean the *semitendinosus* and both heads of the *biceps* thoroughly from end to end (retaining their nerves), and dissect their attachments carefully; and, having pulled the semitendinosus and the long head of the biceps laterally, deal in like manner with the *semimembranosus.*

Posterior Cutaneous Nerve of Thigh (S. 1, 2, 3).—This long, slender nerve arises in the pelvis from the sacral plexus, where it will be examined by the dissectors of the Abdomen. The dissectors of the Lower Limb have found it in the gluteal region, in the back of the thigh and behind the knee, and will trace it later to the back of the leg.

It escapes from the pelvis through the lower part of the greater sciatic foramen in close company with the inferior gluteal nerve and vessels, and appears with these structures in the gluteal region at the lower border of the piriformis near the sciatic nerve; and it descends in the gluteal region, under cover of the gluteus maximus, over the back of the sciatic nerve or along its medial border. Leaving the gluteal region, the two nerves enter the back of the thigh, and part company. The sciatic nerve disappears under cover of the long head of the biceps. The posterior cutaneous nerve runs straight down

the middle of the back of the thigh immediately under cover of the deep fascia. It pierces the deep fascia at the back of the knee, and its terminal part descends in the superficial fascia as far as half-way down the calf of the leg.

Branches.—Its branches are all distributed to skin; some arise in the gluteal region, and some lower down (Fig. 116).

(1) Two or three *gluteal branches* arise in the gluteal region, and wind round the lower border of the gluteus maximus to supply a limited area of skin in the lower part of the buttock. (2) A *perineal branch* arises in the gluteal region and turns medially below the ischial tuberosity across the back of the hamstring muscles to reach the perineum; it gives off a few fine branches to the skin of the uppermost part of the medial side of the thigh, and its terminal branches help to supply the skin of the external genital organs. (3) Several small *branches to the thigh* pierce the deep fascia and supply skin of the medial side and the back of the thigh. (4) The terminal branch ramifies to supply skin of the upper half of the calf of the leg.

FLEXOR MUSCLES.—The muscles of the flexor group are the biceps femoris, the semitendinosus and the semimembranosus, and they are supplied by the sciatic nerve. Their fleshy bellies make up the muscular mass on the back of the thigh; and their tendons in the ham or popliteal region give them the colloquial name of the **hamstrings.**

Biceps Femoris.—The biceps, as its name implies, arises by two heads—a *long* and a *short*—and it is inserted, chiefly, into the head of the fibula. The *long head* arises, by a tendon common to it and the semitendinosus (Fig. 117, p. 233), from the upper medial part of the ischial tuberosity. Some fibres from the sacro-tuberous ligament are continued into it. The *short head* arises from the linea aspera and the upper half of the lateral supracondylar ridge. The tendon of insertion descends across the lateral surface of the knee joint to reach its insertion into the head of the fibula. Near the insertion, the tendon overlies the lateral ligament of the knee, which first grooves the tendon deeply and then splits its lower end into two unequal parts.

Each head of the biceps femoris receives its nerve-supply separately from the sciatic nerve. The branch to the long head is derived from the medial popliteal part of the nerve, and that to the short head from the lateral popliteal part;

and, in a wound, one head may therefore be paralysed without the other head being affected. The muscle as a whole flexes the knee joint and rotates the leg laterally. The long head is also an extensor of the hip joint.

Semitendinosus.—This muscle arises—in common with the long head of the biceps—from the tuberosity of the ischium (Fig. 117, p. 233). The muscular belly ends, in the distal third of the thigh, in a long, cylindrical tendon which passes

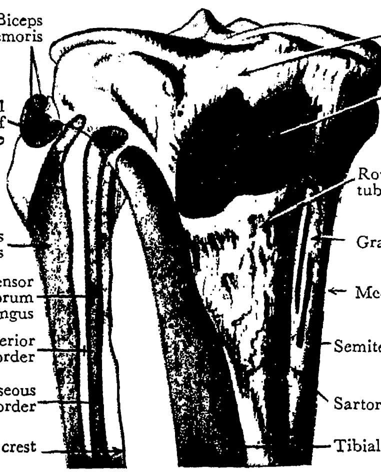


FIG. 127.—Front of upper part of Bones of Leg with Attachments of Muscles mapped out.

downwards on the semimembranosus muscle. At the medial side of the knee, the tendon bends forwards, and spreads out to be inserted chiefly into the upper part of the medial surface of the tibia with the tendon of the gracilis. The *subtendinous bursa of the sartorius* separates these tendons from the tendon of that muscle, and another bursa separates the semitendinosus from the medial ligament of the knee ; the two bursæ communicate so freely that they are, in fact, one bilocular bursa.

The semitendinosus exhibits an incomplete tendinous intersection on its posterior surface and therefore receives two branches from the sciatic nerve, one above and one below it. It is a flexor of the knee, a medial rotator of the leg, and an extensor of the hip joint.

Semimembranosus.—The semimembranosus arises by a broad tendon from the upper lateral part of the tuberosity of the ischium (Fig. 117, p. 233). The tendon of origin passes downwards and medially in front of the biceps femoris

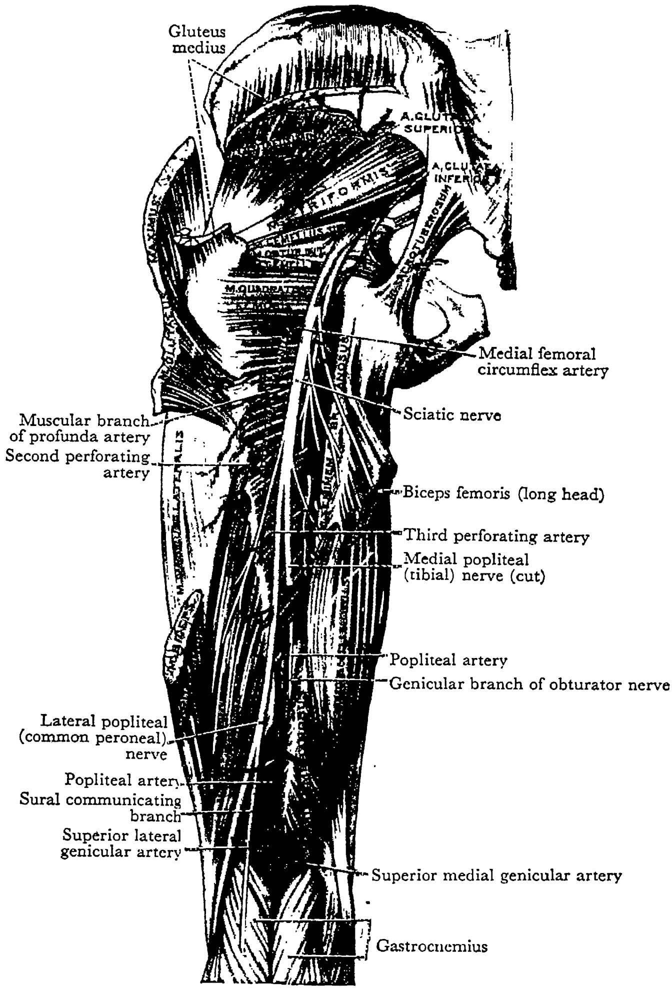


FIG. 128.—Dissection of Gluteal Region and Back of Thigh.

semitendinosus. Examine the origin of the semimembranosus again and then detach it also. The posterior surface of the adductor magnus, now fully exposed, should be cleaned, taking care to preserve the branch from the sciatic nerve that runs across it to enter the muscle near its medial border. Define the insertion of the muscle—which is very extensive—into the back of the femur. At the same time secure the *perforating arteries*. They are a series of four arteries which perforate the adductor magnus at its insertion. Trace them laterally through the gluteus maximus and the short head of the biceps into the vastus lateralis.

The four **perforating arteries** arise in the medial side of the thigh from the profunda artery. They wind round the back of the femur, and end in the vastus lateralis. They anastomose with one another and with neighbouring arteries. They give branches to the adductor and hamstring muscles ; and one or more of them send nutrient arteries into the femur. They will be seen more fully after the limb is removed from the trunk.

Anastomoses on the Back of the Thigh.—In a well-injected subject, a chain of arterial anastomoses can be traced from the gluteal region to the popliteal fossa, and the present is the best time to examine it. In the gluteal region, the superior gluteal artery anastomoses with the inferior gluteal, and the inferior gluteal with the terminal branches of the medial femoral circumflex artery. In the back of the thigh the chain of anastomoses is carried downwards by the medial and lateral femoral circumflex arteries anastomosing with the first perforating artery, and by anastomoses between the perforating arteries. The chain is completed distally by anastomoses between the lowest perforating arteries and the branches of the popliteal artery to the hamstring muscles. This extensive anastomosis provides an alternative route for blood to the leg in case ot obstruction of the femoral artery.

At the end of the fifth day after the subject has been placed upon its face, the gluteal and thigh regions must be thoroughly moistened with preservative fluid, and the skin flaps fixed over them. On the following day, with the body replaced on its back, and the pelvis and thorax supported by blocks, the dissector will proceed to dissect or complete the dissection of the medial side of the thigh, and to examine the hip joint.

MEDIAL SIDE OF THIGH

The group of adductor muscles on the medial side of the thigh is disposed in three strata. The *anterior layer* is composed of the pectineus and the adductor longus, which lie in the same plane. Their adjacent borders touch each other near the pubis, but near the femur they are separated by a small interval. The *second layer* is the adductor brevis alone ; and the *third* or *posterior layer* is the adductor magnus. The gracilis muscle, also an adductor, lies at the surface along the

medial side of the thigh. It is a long, slender muscle—hence the name *gracilis*—and is applied against the adductor brevis and adductor magnus.

The two divisions of the *obturator nerve* are interposed between the three muscular layers—the *anterior division* descending in front of the adductor brevis, and the *posterior division* behind it. The profunda artery is behind the

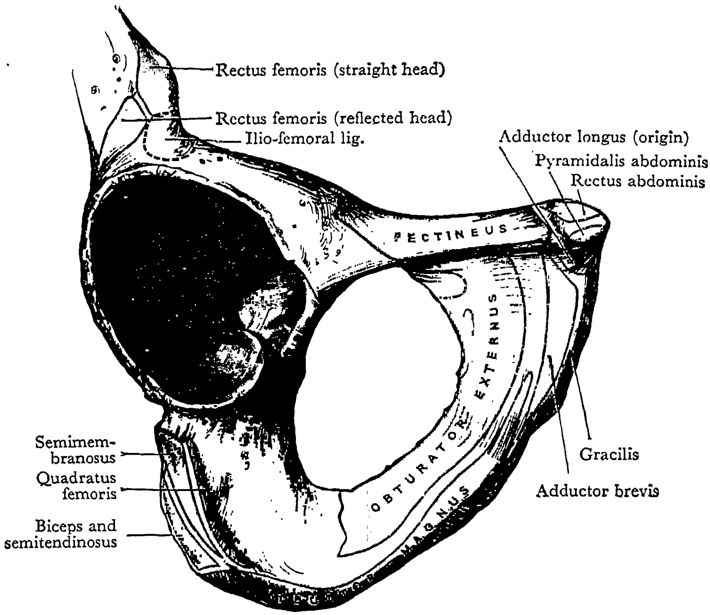


FIG. 129.—External Surface of the Os Pubis, Ischium, and part of Ilium, with Attachments of Muscles mapped out.

adductor longus near the femur ; but it is more easily displayed when the limb has been removed from the trunk.

Adductor Longus.—This muscle is placed at the medial side of the pectineus. It is triangular in shape, being narrow at its origin and expanded at its insertion. It arises from the front of the body of the pubis immediately below the pubic crest (Fig. 129) by a short, strong, flat band which is so curved upon itself that it is like a round tendon; and it is inserted into the linea aspera of the femur by a

very thin aponeurosis which lies between the vastus medialis and the other adductors, and is intimately connected with

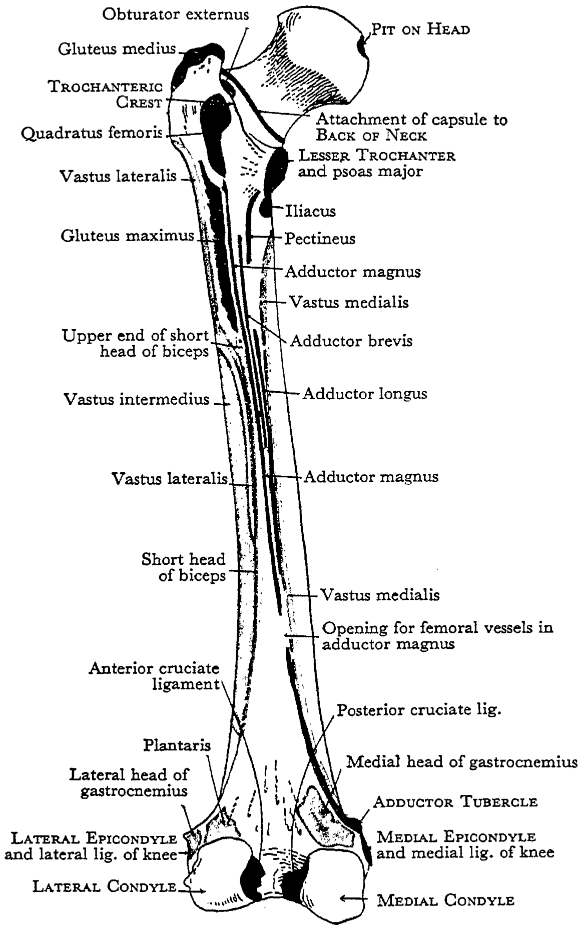


FIG. 130.—Back of Femur, with Attachments of Muscles mapped out.

them. It is supplied by the *anterior division* of the *obturator nerve*. It acts like the adductor brevis (p. 267).

***Dissection.*—Divide the *adductor longus* one inch below its origin. Turn the proximal part upwards and note the character**

of the tendon. Turn the distal portion towards the femur, and secure the nerve of supply. Clean both sides of its aponeurosis as far as possible, separating it from the vastus medialis and the adductor magnus.

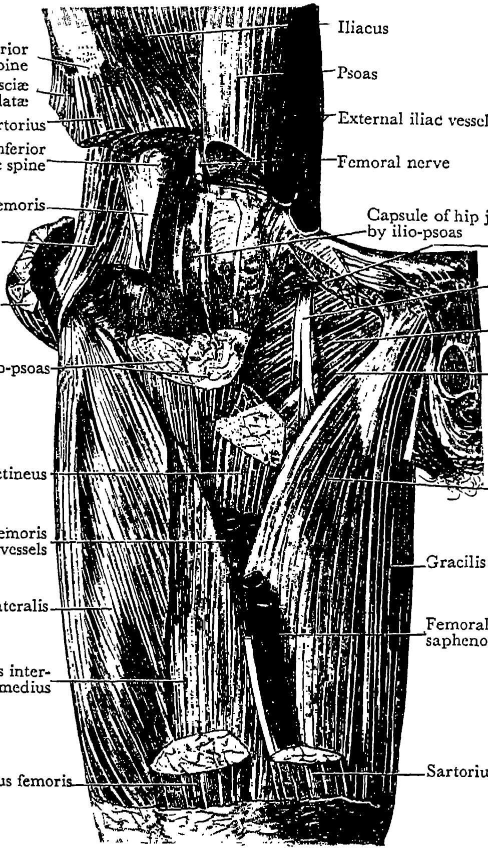


FIG. 131.—Dissection of Front of Right Thigh. The hip joint has been exposed by the removal of parts of the muscles which lie anterior to it.

Pectineus.—The pectineus is placed between the adductor longus and the psoas major. It is flat, and is rather broader at its origin than at its insertion. It has a fleshy origin from the pectineal line and pectineal surface of the pubis (Fig. 129), and descends laterally and backwards to gain insertion into

the back of the femur—into the upper half of a line that extends from the back of the lesser trochanter to the linea aspera (Figs. 130, 134). The pectineus is supplied by the *femoral nerve*. It adducts the thigh and assists in flexion.

Dissection.—Detach the pectineus from its origin, and throw it towards its insertion; at its lateral margin, look for an *accessory obturator nerve* which is occasionally present. Care must also be taken not to injure (1) the anterior division of the obturator nerve, which lies behind the muscle, or (2) the medial circumflex artery which passes backwards between it and the psoas major (Fig. 137). Trace the *medial circumflex artery* still farther backwards, between the adductor brevis and the obturator externus. The *adductor brevis* is below the artery; the *obturator externus* is the fleshy mass above it, closely applied to the front of the pelvis. Clean both these muscles as far as possible.

Accessory Obturator Nerve.—This slender nerve, when present, arises either from the lumbar plexus or from the obturator trunk near its origin. It descends across the superior ramus of the pubis along the medial side of the psoas major into the thigh. If small, it ends in the hip joint or in the pectineus; if larger, it usurps the distribution of the obturator nerve to an extent that varies with its size (Fig. 132).

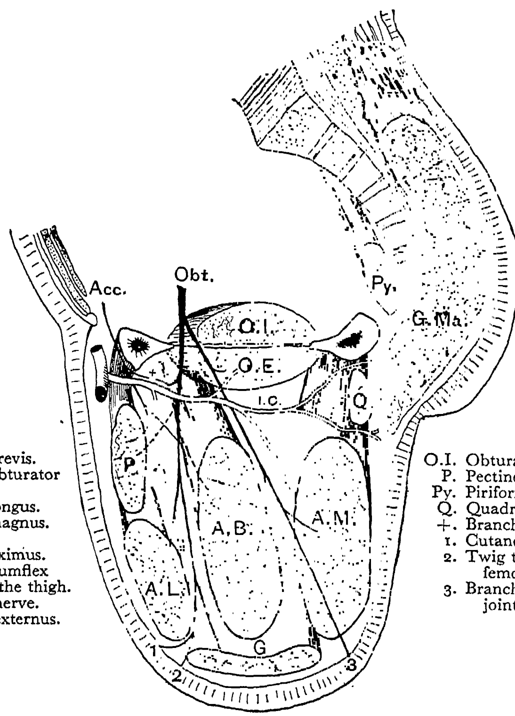
Medial Circumflex Artery.—This artery usually springs from the profunda femoris artery at the same level as the lateral circumflex branch, but sometimes it springs directly from the femoral trunk. It passes backwards, out of the femoral triangle, between the psoas and the pectineus, and then between the obturator externus and the adductor brevis, to reach the back of the thigh, where, close to the lesser trochanter, it divides into an ascending and a transverse terminal branch. Before the main trunk divides it gives off:—(1) *muscular branches*, and (2) an *articular branch* which enters the hip joint through the acetabular notch. The terminal branches have been described on p. 243.

Adductor Brevis.—The adductor brevis is behind the adductor longus and the pectineus, and in front of the adductor magnus. It arises from the front of the os pubis below the origin of the adductor longus (Fig. 129). As it descends, it inclines backwards and laterally; and it is inserted into the lower two-thirds of the line which extends from the lesser trochanter to the linea aspera (Fig. 134), and into the upper part of the linea aspera. It is supplied by the *obturator nerve*. Like all the other adductor muscles, it is an adductor, a flexor and a lateral rotator of the thigh.

Dissection.—Divide the adductor brevis close to its origin, and turn it towards its insertion, but do not injure the anterior division of the *obturator nerve*, which lies in front of it. When the muscle is reflected the *posterior division of the nerve* will be

exposed. Trace it upwards to the obturator foramen, and downwards into the adductor magnus. Clean a further part of the *obturator externus*. Define the origin of the adductor magnus from the side of the pubic arch ; and clean its anterior surface as far as possible towards its insertion, separating it from the adductor brevis.

Obturator Nerve (L. 2, 3, 4).—The obturator nerve



A.B. Adductor brevis.
Acc. Accessory obturator nerve.
A.L. Adductor longus.
A.M. Adductor magnus.
G. Gracilis.
G.Ma. Gluteus maximus.
I.C. Medial circumflex artery of the thigh.
Obt. Obturator nerve.
O.E. Obturator externus.

O.I. Obturator internus.
P. Pectineus.
Py. Piriformis muscle.
Q. Quadratus femoris.
+. Branch to hip joint.
1. Cutaneous branch.
2. Twig to walls of femoral artery.
3. Branch to knee joint.

FIG. 132.—Diagram to illustrate Distribution of Obturator Nerve and general disposition of Adductor Muscles of Thigh.

arises in the abdomen proper from the lumbar plexus (Fig. 102, p. 200), and descends into the pelvis. It escapes from the pelvis by passing, with its companion vessels, through the upper or anterior part of the obturator foramen (Fig. 133). While still within the foramen it splits into an anterior and a posterior division.

The *anterior division* enters the thigh over the upper

border of the obturator externus muscle, and runs downwards on the anterior surface of the adductor brevis, behind the pectineus and adductor longus. It gives branches to three muscles, viz., the adductor longus, the adductor brevis and the gracilis. In addition, it gives off—(1) an

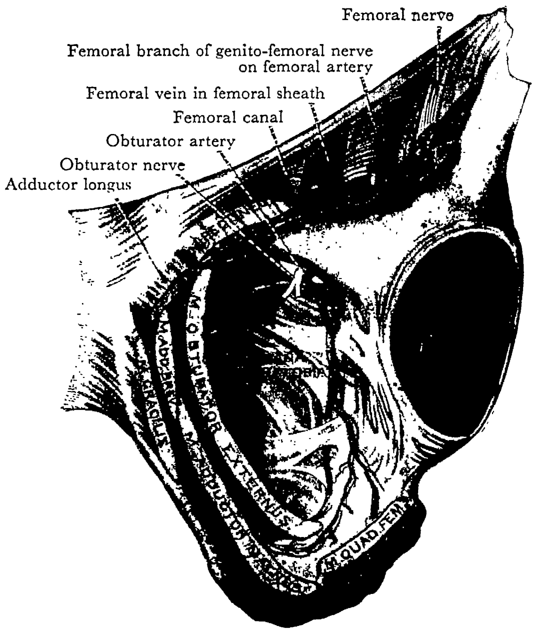


FIG. 133.—Dissection to show Structures around Obturator Foramen of Hip-Bone.

articular branch to the hip joint (Fig. 132, +); (2) a fine twig which appears at the distal border of the adductor longus, joins the subsartorial plexus and then becomes cutaneous; and (3) a *terminal twig* which goes to the femoral artery (Fig. 132) and breaks up into fine filaments upon its walls.

The *posterior division* of the obturator nerve, as it enters the thigh, pierces the obturator externus near its upper border. It descends between the adductor brevis and the adductor magnus, and is expended chiefly in the supply of the magnus. It gives also, however, a branch to the obturator externus, an occasional one to adductor brevis, and an articular branch to

the knee joint. This *genicular branch* pierces the lower part of the adductor magnus and enters the back of the knee joint (p. 257).

Gracilis.—This long, slender muscle lies along the medial side of the thigh and knee. It springs, by a thin, wide tendon, from the lower half of the body of the pubis, close to the symphysis, and also from the upper half of the side of the pubic arch (Fig. 129). It ends in a thin, rounded tendon which inclines forwards, below the knee, and then expands to be inserted into the upper part of the medial surface of the tibia (Fig. 127, p. 260). Two inter-communicating bursæ separate the tendon of the gracilis from the medial ligament of the knee joint and from the tendon of the sartorius.

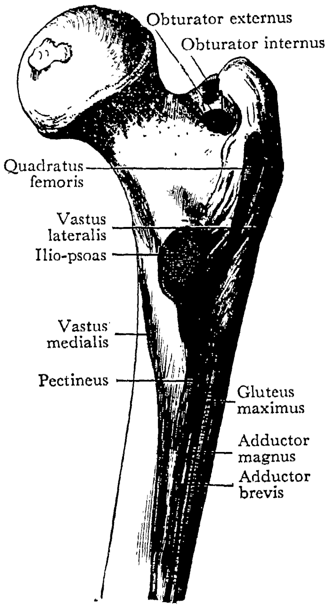


FIG. 134.—Back of upper part of Femur, with Attachments of Muscles mapped out.

The gracilis is supplied by the *anterior division* of the *obturator nerve*. It adducts the thigh, flexes the knee joint and rotates the leg medially.

Adductor Magnus.—The adductor magnus is one of the most powerful muscles of the thigh. It is a thick, flat, fleshy mass which springs from the side of the pubic arch and the lower part of the ischial tuberosity (Figs. 129, 133). The part from the arch spreads out to gain an extensive linear insertion into the back of the femur, being attached to the medial side of the gluteal tuberosity, to the linea aspera, to the medial supracondylar ridge; the more medial bundles are the more horizontal; the more lateral are the more oblique in direction (Figs. 130, 140). The part from the tuberosity descends almost vertically and forms the postero-

medial border, which is the thickest part of the muscle; in the distal third of the thigh, it ends in a strong, rounded tendon which is inserted into the adductor tubercle (Figs. 121, 130). This tendon is further attached to the femur by the medial intermuscular septum, which stretches between it and the medial supracondylar ridge.

At the gluteal tuberosity and the linea aspera, the insertion is interrupted by the passage of the perforating vessels. At these spots, tendinous fibres are developed in the muscle, and they arch over the vessels to protect them. The opening for the femoral vessels is in series with those arches, and is situated at the supracondylar ridge about the junction of the middle and lower thirds of the thigh (Fig. 140).

The adductor magnus has a double nerve-supply. The part inserted into the adductor tubercle is associated at its origin with the hamstrings; it belongs, as noted already (p. 262), to the flexor group and is therefore supplied by the medial popliteal part of the *sciatic nerve*; the rest of the muscle—the true adductor part—is supplied by the posterior branch of the *obturator nerve*.

The adductor portion acts like the other adductor muscles—that is, it adducts the thigh, rotates it laterally, and helps to flex the hip joint. The hamstring portion extends the hip joint.

Dissection.—Detach the adductor magnus from the side of the public arch, and complete the cleaning of the *obturator externus* muscle.

Obturator Externus.—This flat, fan-shaped muscle overlies the obturator membrane. It springs from the medial half of the membrane, and also from the medial and lower margins of the obturator foramen (Figs. 129, 133). It passes backwards and laterally, below the neck of the femur and the capsule of the hip joint, and then curves upwards and laterally on to the back of the neck of the femur, to end in a stout tendon which obtains insertion into the floor of the trochanteric fossa (Figs. 130, 134). This tendon has been examined in the dissection of the gluteal region (p. 242).

The obturator externus is supplied by the *posterior division* of the *obturator nerve*. It is a flexor and a lateral rotator of the thigh.

Dissection.—Detach the obturator externus carefully from its origin in order to expose the *obturator artery* and its terminal

branches. Release the posterior division of the *obturator nerve* from the substance of the muscle, and avoid injury to its anterior division.

Obturator Artery.—The obturator artery arises in the pelvis from the internal iliac. It accompanies the nerve through the obturator foramen, and, as soon as it enters the thigh, it divides into two terminal branches which diverge from each other and form an arterial circle on the obturator membrane under cover of the obturator externus. Both branches give twigs to the neighbouring muscles; and the *posterior branch* sends an *articular twig* through the acetabular notch into the hip joint. When the joint is opened this twig may be followed, in a well-injected subject, into the head of the femur along the ligament of the head.

Psoas Major and Iliacus.—Both the psoas major and the iliacus muscles arise within the abdomen, and they enter the thigh behind the inguinal ligament. A tendon appears on the lateral side of the psoas major, and finally the whole muscle ends in the tendon, which is inserted into the lesser trochanter of the femur. The iliacus lies at the lateral side of the psoas, and is inserted, by fleshy fibres, into the tendon of the psoas, into the lesser trochanter and the surface of the femur below it. The united ilio-psoas at first descends over the front of the capsule of the hip joint, and then passes backwards underneath it to reach its insertion. A synovial *bursa* intervenes between it and the front of the capsule, and facilitates the play of the united muscle over the joint. The bursa may communicate with the joint through an aperture in the capsule (Figs. 131, 137).

The ilio-psoas is the chief flexor of the thigh: conversely, if the lower limbs are fixed, it is a flexor of the trunk as in raising it from the supine position. Flexion of the thigh is accompanied by slight medial rotation owing to the relation of the muscle to the axis of rotation of the femur. But, if the femur is broken below the trochanter, the ilio-psoas not only flexes the proximal fragment at once but rotates it laterally.

***Dissection.*—Divide the femoral vessels and nerve below the inguinal ligament, and tie them separately to a small piece of wood. Cut through the sartorius and the rectus femoris, about two inches from their origins, and turn them aside. Divide the ilio-psoas near its insertion and turn the two parts**

PLATE XXVII

FIG. 135.—Radiograph of Female Pelvis (girl aged 17).

Note the continuity of the lines of lower borders of superior pubic ramus and neck of femur, and compare with Figs. 136 and 142.

[Facing p. 272

FIG. 136.—Radiograph of Hip of youth aged 17.

All three epiphyses of the Femur are united. Note the continuity of the lines of the lower borders of the superior pubic ramus and the neck of the femur (Shenton's line), seen also in Figs. 135 and 142.

upwards and downwards. This will expose the psoas bursa and the capsule of the hip joint. Open the bursa and ascertain its extent with the finger, and note whether or not it communicates with the joint.

Turn aside the tensor fasciæ latæ. If the gluteus minimus still adheres to the capsule, release it, and throw it laterally and downwards, but do not detach it from the trochanter. Raise

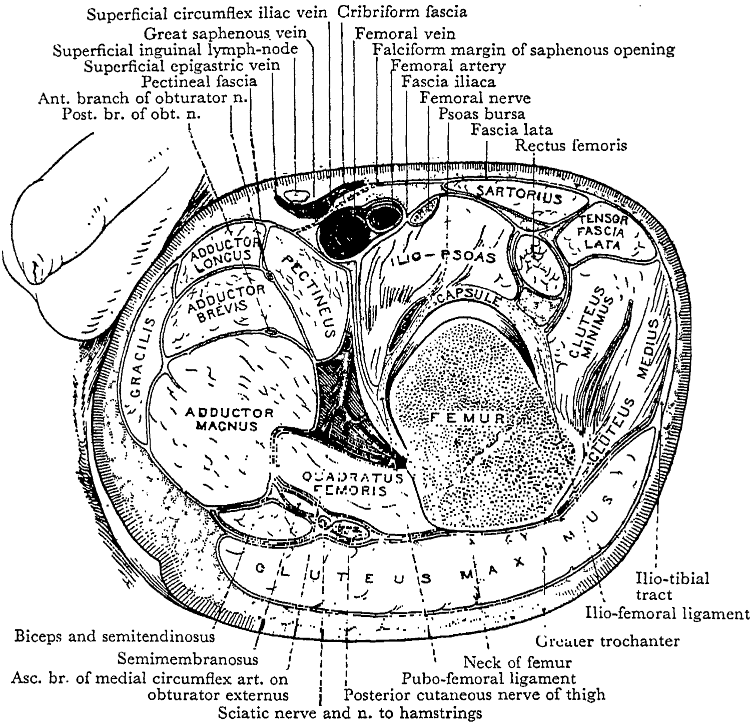


FIG. 137.—Dissection of Oblique Section through Upper Part of Thigh. Showing relations of the Hip Joint.

the upper part of the rectus femoris, and clean its reflected head. Lastly, clean the anterior part of the capsule of the hip joint.

HIP JOINT

The hip-joint is the most perfect example of a ball-and-socket joint in the body. It does not allow so free a range

of movement as that which takes place at the shoulder joint, but what it loses in this respect it gains in strength and stability. Its great strength and security depend:—(1) upon the depth of the acetabulum and upon the fact that its mouth is reduced in width by a circular band called the labrum

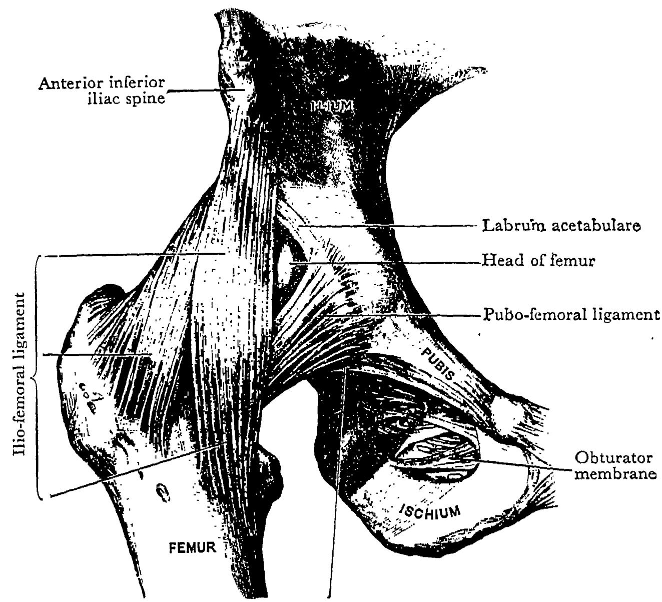


FIG. 138.—Ligaments of Hip Joint from the front.

acetabulare, which is attached to its lips; (2) upon the tension and strength of the ligaments; (3) upon the length and oblique direction of the neck of the femur; (4) upon the strength of the surrounding muscles; and (5) upon atmospheric pressure.

Ligaments of the Hip Joint.—In addition to the thickened portions of the fibrous capsule, which are described under special names, there are three other ligamentous structures associated with this joint.

The fibrous capsule and the ligament of the head of the femur are attached to both bones of the joint. The transverse ligament of the acetabulum and the labrum acetabulare

are connected with the hip-bone only; the transverse ligament partially fills the acetabular notch; the labrum encircles the mouth of the acetabulum, and serves to deepen it still further.

Articular Capsule.—The fibrous capsule is exceedingly strong, and surrounds the joint on all sides. *Proximally*, it is attached around the acetabulum. *Distally*, it clasps the neck of the femur: the anterior part of this attachment is to the whole length of the intertrochanteric line and to the root of the greater trochanter, and it is very firm and strong; posteriorly, it falls short of the intertrochanteric crest by about half an inch, and its attachment to the neck of the femur is weak.

When the capsule of the hip joint has been carefully cleaned, it will be seen that the fibres which compose it run in two different directions. The majority pass obliquely from the hip-bone to the femur. There are, however, other fibres which lie more or less at right angles to the oblique fibres. They constitute the *zona orbicularis* and are seen to advantage in the posterior and inferior parts of the capsule, where they were noted during the dissection of the gluteal region (p. 245). The oblique fibres are most massed on the front of the joint.

There are three thickened portions of the capsule which deserve special description as ilio-femoral, pubo-femoral and ischio-femoral ligaments.

The **ilio-femoral ligament** is placed over the front of the joint, and is the thickest and most powerful part of the capsule. Proximally, it is attached to the anterior inferior iliac spine and to the depressed surface immediately lateral to that spine. Distally, it widens to be attached to the trochanteric line of the femur. It is thicker at the sides than in the middle, and these thickenings give the ligament the appearance of an inverted Y (Fig. 138).

The ilio-femoral ligament is fully a quarter of an inch thick, and is one of the strongest ligaments in the body—its only rival being the interosseous sacro-iliac ligament. A strain varying from 250 lbs to 750 lbs is required for its rupture (Bigelow). It is rarely torn asunder in dislocation of the hip joint, and, consequently, the surgeon is able in most cases to overcome the displacement by manipulation.

The *pubo-femoral ligament* is the name applied to fasciculi

which spring from the pubic bone and the obturator membrane, and join the lower and anterior part of the capsule. When the bursa of the ilio-psoas is continuous with the cavity of the joint, the aperture of communication is placed between this band and the ilio-femoral ligament.

The *ischio-femoral ligament* is a comparatively weak band which springs from the ischium below the acetabulum, and passes upwards and laterally to blend with the posterior part of the capsule.

Movements permitted at the Hip Joint.—Before the capsule of the joint is opened, the range of movement which is permitted at the hip joint should be tested. *Flexion,* or forward movement, is very free, and is checked by the thigh coming into contact with the abdominal wall. *Extension,* or backward movement, is limited by the ilio-femoral ligament. That powerful ligament has a most important part to play in preserving the upright attitude with the least possible expenditure of muscular exertion. In the erect posture the line of gravity falls slightly behind the line joining the central points of the two hip joints. In that posture also the ilio-femoral ligaments are tense, and prevent the pelvis from rolling backwards on the heads of the femora. *Abduction,* or lateral movement of the limb, is checked by the pubo-femoral ligament. *Adduction,* or medial movement (*e.g.,* as in crossing one thigh over the other), is limited by the lateral portion of the ilio-femoral ligament and the upper part of the capsule. *Rotation medially* tightens the ischio-femoral ligament, and is therefore, in a measure, restrained by it. *Rotation laterally* is limited by the lateral portion of the ilio-femoral ligament. In *circumduction,* which is produced by combination of the movements of flexion, abduction, extension, and adduction, different parts of the fibrous capsule are tightened at different stages of the movement.

Dissection.—The hip joint should now be opened. Isolate the *ilio-femoral ligament* by incisions along its borders, and then remove all other parts of the capsule. The object of this dissection is to enable the dissector to appreciate the thickness and great strength of the ilio-femoral ligament. Divide it when it has been examined.

Transverse Ligament of Acetabulum.—This is a strong band of fibres that bridges across the acetabular notch, and is attached to the margins of the notch. It completes the rim of the acetabulum, and converts the notch into a foramen through which vessels and nerves enter the joint.

Labrum Acetabulare.—The *acetabular lip* is a firm fibro-cartilaginous ring which is fixed to the rim of the acetabulum ; it deepens the cavity of the acetabulum, and at the same time narrows its mouth to a slight extent. The labrum fits closely upon the head of the femur, and, acting like a sucker, exercises an important influence in retaining it in place. Both surfaces of the labrum are covered with synovial membrane ;

its free margin is thin, but it is much thicker at its attachment to the acetabular rim.

Ligament of Head of Femur.—This band was formerly called the "ligamentum teres" (*Teres* = round), but it is flat and fan-shaped. Its narrow end is implanted into the

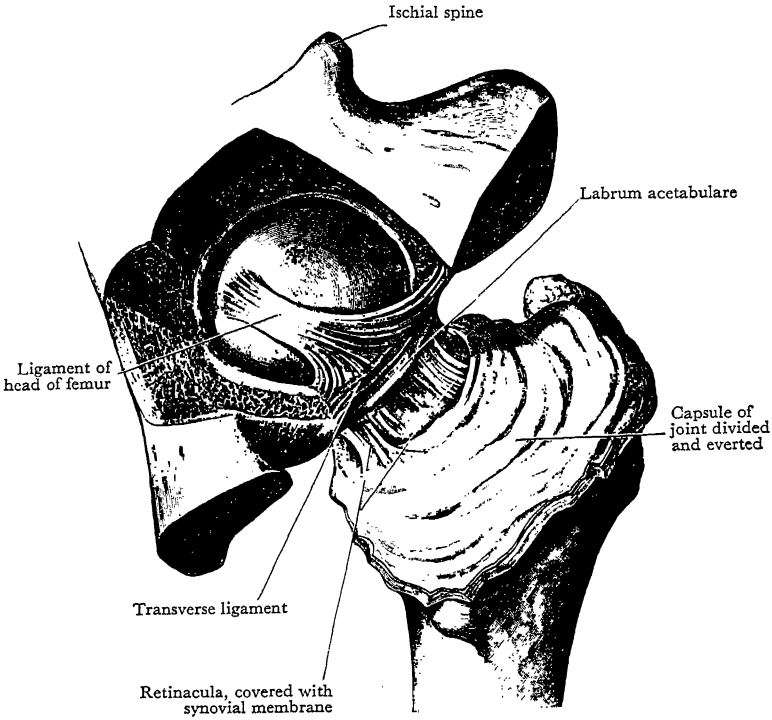


FIG. 139.—Hip Joint opened from behind. The bottom of the acetabulum has been removed to show the Ligament of Head of Femur.

pit on the head of the femur ; its flattened end is bifid, and is fixed to the margins of the acetabular notch, and also to the transverse ligament. This attachment can be defined by the removal of the synovial membrane and some areolar tissue. The ligament is surrounded by a prolongation of the synovial membrane ; and a small artery runs along it to the head of the femur.

It is difficult to understand the part which the ligament plays in the mechanism of the hip joint. It presents very different degrees of strength in different subjects. It becomes very tense when the thigh is slightly flexed and then adducted—which, however, is an attitude seldom taken up.

Synovial Membrane and Interior of the Joint.—A mass of soft fat occupies the fossa of the acetabulum. Upon this the ligament of the head of the femur is placed; and articular twigs from the obturator vessels and nerve enter it by passing through the acetabular notch.

The **synovial membrane** lines the inner surface of the fibrous capsule; it is reflected from it on to the neck of the femur, and it clothes the bone as far as the margin of the articular cartilage of the head. Along the line of reflexion, some fibres of the fibrous capsule run upwards on the neck of the femur and raise up ridges of the synovial membrane. These fibres are termed the *retinacula* of the neck of the femur.

The *retinacula* are of some surgical importance. In intracapsular fracture of the neck of the femur they may escape rupture, and they may then, to some extent, help to retain the fragments in apposition—hence the name *retinacula*. Like the ligament of the head, they serve as pathways for small arteries of supply to the head of the femur.

At the acetabular attachment of the capsule, the synovial membrane is reflected on to the labrum acetabulare and invests both its surfaces. It covers also the articular surface of the transverse ligament and the cushion of fat which occupies the acetabular fossa. Lastly, it gives a tubular investment to the ligament of the head of the femur.

Blood-Vessels and Nerves.—The *arteries* that supply the hip-joint are derived from the gluteal, circumflex and obturator arteries. The *nerves* come from (1) the nerve to quadratus femoris, (2) the femoral, through the nerve to rectus femoris, (3) the anterior division of the obturator nerve, and (4), occasionally, the accessory obturator.

Removal of the Lower Limb.—Divide the ligament of the head of the femur, and remove the limb from the trunk. Take the limb to one of the tables set aside for the dissection of separate parts. Revise the attachments of muscles and complete the dissection of the thigh.

Trochanteric and Adductor Muscles and Profunda Femoris Artery

The student will now clean the distal parts of the muscles attached to the trochanters, and will define and examine their insertions. He will then be enabled also to examine the femoral attachments of the fibrous capsule of the hip joint more satisfactorily. When that has been done, he will complete the dissection of the pectineus and the adductors, and will expose the distal part of the profunda artery and the origin of its perforating branches.

Dissection.—Identify the muscles which are inserted into the greater trochanter. They are—*gluteus minimus* and *medius*, *quadratus femoris*, *piriformis*, *obturator internus* and *externus*. Clean them in turn, and define their insertions. Do not be satisfied till each muscle hangs quite freely from its insertion.

Deal in like manner with the *ilio-psoas*, which is inserted chiefly into the lesser trochanter.

Then, re-examine the *articular capsule* of the hip joint and note the femoral attachment of its fibrous part. Evert the capsule, and note how the *synovial membrane* is reflected off the fibrous capsule, and extends as a close-fitting tube over the neck of the femur up to the head. Strip off the synovial membrane to display the *retinacula*.

Come now to the adductor region and define the attachments of the pectineus and the adductors—longus, brevis, magnus—to the femur. The *adductor longus* requires most care because of its extreme thinness as it approaches the bone.

As you separate the adductor longus from the other muscles you will find the *profunda vessels* behind the longus, close to the femur—the vein in front of the artery. Clean the profunda vein and preserve it, but remove its tributaries. Then, clean the artery. Divide the branches which it gives to muscles in this situation ; but clean and preserve those of its branches which cling to the femur : they are the *perforating arteries*.

After confirming the statements which have been made about the attachments of the muscles, proceed to the study of the profunda vessels.

Profunda Femoris Artery.—This large vessel is the chief artery of supply to the muscles of the thigh. It arises, in the femoral triangle, from the postero-lateral side of the femoral artery, about an inch and a half or two inches below the inguinal ligament. It descends with a curve medially which brings it behind the femoral vessels in the lower part of the triangle ; it leaves the triangle by

passing through the floor between the pectineus and the adductor longus, and then descends behind the adductor longus, close to the femur; by giving off large branches it is rapidly reduced in size, and it ends a little below the middle of the thigh as a fine terminal vessel, called the *fourth perforating artery*, which passes backwards through the adductor magnus.

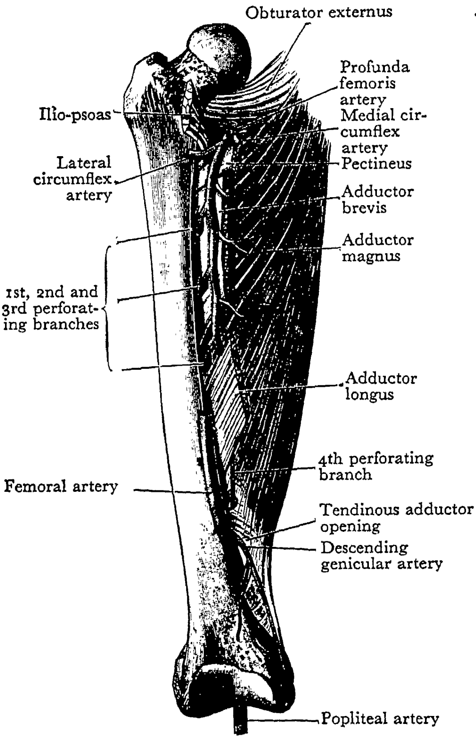


FIG. 140.—Profunda Femoris Artery and its Branches.

At first, the profunda lies lateral to the femoral artery, behind the skin and fasciæ; as it inclines medially, it passes behind its own vein and the femoral vessels; after it leaves the triangle, it lies on the adductor brevis and the adductor magnus, behind its own vein and the adductor longus; and that muscle separates the profunda vessels from the femoral vessels.

The branches of the profunda femoris are the *lateral* and *medial circumflex* arteries, the four *perforating* arteries, and unnamed *muscular* arteries.

The **circumflex arteries** have been studied already (pp. 221, 267). The **muscular branches** are inconstant in origin, number and size. They supply the adductor muscles, and some of them pierce the adductor magnus to reach the hamstring muscles.

Perforating Arteries.—These four arteries arise in series from the profunda—the first, when it slips behind the adductor longus, and the fourth as its terminal branch. They wind round the back of the femur,

sometimes grooving the bone, and they all end in the vastus lateralis. As they pierce the muscles attached to the back of the femur, they are protected by fibrous arches. On their way, they give branches to the adductors and the hamstrings; the second or the third sends a *nutrient artery* into the femur, and another nutrient artery may arise from the fourth. For the part taken by these arteries in the anastomoses on the back of the thigh, see p. 263.

When the study of the medial side of the thigh is completed, the student will proceed to the examination of the leg and the foot, beginning with their surface-anatomy.

LEG AND FOOT

Surface-Anatomy.—The head of the fibula, the condyles and tubercle of the tibia have been examined already. Identify them again.

The malleoli are the prominences at the sides of the ankle, and they grip the talus between them. The **medial malleolus** is a thick, downward projection from the lower end of the tibia; the **lateral malleolus** is the lower end of the fibula. Their posterior surfaces are in the same vertical transverse plane. The lateral malleolus is the narrower and therefore does not extend forwards so far as the medial one does, but it juts downwards farther, and articulates, therefore, with a larger area of the talus.

The **neck of the fibula** and the greater part of its **shaft** are buried among muscles, but can be felt through them. The lower part of the shaft is subcutaneous, and is the bone felt above the lateral malleolus.

The shin is the **anterior border of the shaft of the tibia.** It is inconspicuous; but it is subcutaneous, and is readily felt if the finger is passed along it. It runs slightly sinuously from the tuberosity of the tibia to the anterior margin of the medial malleolus; it is a sharp edge except towards its lower end. The **medial surface of the tibia,** wide and flat, is easily felt from end to end. Its uppermost part is covered by the tendons of the sartorius, gracilis and semitendinosus; the rest is subcutaneous. The **medial border** of the tibia also is easily felt from end to end; the saphenous nerve and the great saphenous vein run along it.

On the back of the leg, the fleshy prominence of the calf

is due to the gastrocnemius and the underlying soleus. These two muscles are thrown into contraction when the heel is raised—*e.g.*, in standing on the toes. The outlines of the two heads of the gastrocnemius are then clearly seen, if the limb is thin ; it is obvious also that the soleus reaches farther down, and that, at the middle of the calf, it is wider than the gastrocnemius. The muscles taper inferiorly to become continuous with the **tendo calcaneus,** which is the strong, thick tendon above the heel. Grasp the tendo calcaneus between finger and thumb. Note that it is nearly an inch behind the bones of the leg, the interval being filled with fat and fibrous tissue. Press the fingers on the anterior wall of the hollows at the sides of the tendo calcaneus : the backs of the malleoli can be felt, though tendons cover them ; and, on the medial side, the pulse of the **posterior tibial artery** may be felt in the living limb.

The bone of the heel is the calcaneus. Grip its posterior part between finger and thumb. The **lateral** and **medial tubercles** of its lower surface make low, blunt prominences on the sides near the sole. Its **lateral surface** is nearly all subcutaneous, and is easily felt below the lateral malleolus as a wide surface that extends forwards from the back of the heel for two inches or more. The **peroneal trochlea** (when present) is felt as a little prominence about a finger's breadth below the lateral malleolus. On the medial side, the **sustentaculum tali** provides the bony resistance felt a thumb's breadth below the medial malleolus.

The **talus** rests on the upper surface of the calcaneus. Its *body* is hidden below the tibia, between the malleoli ; but when the foot is extended (*i.e.*, when the toes are pointed) the anterior part of the body protrudes from below the tibia. Invert the foot (*i.e.*, twist it so that the sole looks medially) : the *head* of the talus then makes a rounded prominence about an inch in front of the lateral malleolus ; and, lateral to the head of the talus, the anterior end of the calcaneus makes an uneven projection.

On the medial side of the foot, the landmark most often referred to is the **tuberosity of the navicular bone.** It makes a prominence, blunt and indistinct but easily felt, an inch or an inch and a half below and in front of the medial malleolus, about midway between the back of the heel and the root of the big toe, at the level of the lip of the shoe. The

bones felt in front of the tuberosity are first the **medial cuneiform bone** and then the **first metatarsal bone.**

On the lateral side, the **tuberosity of the fifth metatarsal bone** is a prominent landmark, midway between the point of the heel and the root of the little toe. The **cuboid bone** lies hidden in the side of the foot between that tuberosity and the calcaneus. The **head of the fifth metatarsal bone** is at the root of the little toe, at the widest part of the foot, and is often a rounded bulging. Note that it is much farther back than the root of the big toe, and that, when the foot is shod, it is so far from the toe of the shoe that it may be mistaken for the *base* of the fifth metatarsal bone.

On the dorsum of the foot, the metatarsus and the anterior part of the tarsus are under the extensor tendons and the extensor digitorum brevis muscle ; but the **metatarsal bones** can be felt individually through them. The **extensor digitorum brevis** forms the soft, fleshy pad in front of the lateral malleolus ; and, when the foot and toes are raised, the tendons spring up, and can be individually recognised by the student after he has dissected the region. Unlike the joints of the fingers, the joints of the toes do not have landmarks to indicate their position ; their position is ascertained by manipulation.

In the sole of the foot, the soft parts are so thick that there are no bony landmarks. The middle of the medial part of the sole is raised from the ground ; that part presents, therefore, a wide concavity, which, however, is flattened down and more or less obliterated in the condition known as "flat-foot". The concavity is bounded posteriorly by the **pad of the heel,** and laterally by the elevation that underlies the calcaneus, cuboid and fifth metatarsal bone. The anterior boundary is the **ball of the foot,** which underlies the metatarso-phalangeal joints ; its medial part is the **ball of the big toe,** whose large size is due chiefly to the two sesamoid bones that lie on the plantar surface of the joint.

The smaller toes are usually flexed so permanently that the only parts seen in the sole are the pads that cover the terminal phalanges ; the other phalanges are hidden in a narrow groove. But the groove widens medially, so that the skin over the other phalanges of the second and first toes can be seen, and they can be felt through it.

Front of Leg and Dorsum of Foot

It is convenient to dissect the dorsum of the foot at the same time as the front of the leg, so that the structures that pass over the ankle may be studied in their continuity.

Dissection.—Reflexion of Skin.—Raise the knee on a block; extend the foot, and fasten it to the table with hooks. Reflect the skin from the lateral and medial sides of the leg as well as from the front. *Incisions* :—(1) a vertical cut along the middle line of the leg and dorsum of the foot to the root of the middle toe; (2) a transverse incision across the ankle joint; (3) a transverse incision across the roots of the toes.

Raise the four flaps of skin, thus mapped out (10, 11, 12, 13, Fig. 99, p. 192), from the subjacent fatty tissue, and dissect out the superficial veins and nerves.

Superficial Fascia.—The superficial fascia of the front and the medial and lateral sides of the leg and the dorsum of the foot presents no peculiar features; and it contains, as a rule, only a moderate amount of fat.

The superficial veins and the cutaneous nerves are now to be sought and displayed.

Dissection.—The *lateral cutaneous nerve of the calf* was found in the dissection of the popliteal fossa. Trace it now to its termination on the antero-lateral aspect of the leg.

Dissect the cutaneous veins next, for, on the dorsum of the foot, they are more superficial than the nerves, and in other situations they serve as guides to the nerves. Begin with the *dorsal venous arch.* It lies across the anterior part of the metatarsus. Follow it to the medial border of the foot, where it joins the commencement of the *great saphenous vein.* Next, follow that vein upwards to the medial border of the tibia. Do not follow it farther at present, but secure the *saphenous nerve,* which lies close to it, and follow the nerve into the foot.

Now, follow the dorsal venous arch to the lateral margin of the foot, where it joins the commencement of the *small saphenous vein.* Follow the small saphenous vein backwards below the lateral malleolus, and there secure the *sural nerve,* which lies adjacent to the vein. Follow the sural nerve to the little toe, and, about the middle of the lateral border of the foot, secure the communicating twig which it gives to the lateral branch of the musculo-cutaneous nerve.

Come back to the dorsal venous arch. Find the *dorsal digital veins,* and trace them on to the toes.

Now, cut down through the fat, at the junction of the middle and distal thirds of the leg, about an inch to the medial side of the fibula, and secure the trunk of the *musculo-cutaneous nerve* as it pierces the deep fascia. Follow it downwards to its division into medial and lateral branches, and then trace them and their subdivisions to their terminations on the toes.

Lastly, dissect in the fascia between the first two metatarsal bones and find the *cutaneous branch of the anterior tibial nerve* as it pierces the deep fascia ; trace it and its branches to the adjacent sides of the first and second toes.

Cutaneous Veins.—There are two *dorsal digital veins* in each toe—one on each side of the dorsum of the toe. Those along adjacent sides of two toes unite to form a common stem which ends in the dorsal venous arch ; those from the medial side of the big toe and lateral side of the little toe join the ends of the arch.

The *dorsal venous arch* lies in the superficial fascia on the anterior parts of the shafts of the metatarsal bones, superficial to the terminal branches of the musculo-cutaneous nerve, and receives the veins of the dorsum of the foot and toes. Its medial end joins the medial dorsal digital vein of the big toe to form the great saphenous vein ; and its lateral end unites with the lateral dorsal digital vein of the little toe to form the small saphenous vein.

The *small saphenous vein* runs backwards below the lateral malleolus, and then upwards behind it into the leg.

The *great saphenous vein* passes backwards along the medial side of the foot, and ascends in front of the medial malleolus into the leg, where it passes obliquely across the distal third of the tibia to reach its medial border, along which it ascends. In the lower part of the leg, the great saphenous vein and the saphenous nerve are very liable to injury, for they lie quite superficially between the skin and the bone.

Most of the superficial veins of the medial side of the foot and of the front of the leg end in the great saphenous vein.

Cutaneous Nerves.—Branches of three nerves supply the skin of the front of the leg ; branches of three nerves supply the dorsum of the foot ; the dorsal surfaces of the toes are, for the main part, supplied by branches of three nerves ; only one nerve is common to all three regions—the musculo-cutaneous.

The account given below of the cutaneous nerves of the dorsum of the foot and toes indicates the general arrangement most often met with, but the dissector must be prepared to meet with many variations especially on the lateral side, where the sural nerve and the lateral division of the musculo-cutaneous nerve not uncommonly replace each other to a greater or less extent.

The upper part of the front of the leg is supplied by the *infrapatellar branch of the saphenous nerve* (L. 3, 4), and

other small branches of that nerve are distributed to the medial part of the front of the leg (Fig. 104, p. 202).

The *lateral cutaneous nerve of the calf* (L. 5, S. 1, 2) (p. 255) is distributed to the skin between the infrapatellar region and the junction of the middle and distal thirds of the leg. The remainder of the front of the leg is supplied by the *musculo-cutaneous nerve.*

The medial side of the dorsum of the foot is supplied by the *saphenous nerve*, the lateral side by the *sural nerve*, and the intermediate area by the *musculo-cutaneous nerve.*

The adjacent sides of the first and second toes are supplied by the *medial division of the anterior tibial nerve*, the lateral side of the little toe by the *sural nerve*, and all the remaining parts by branches of the *musculo-cutaneous nerve.*

The skin of the dorsum of the terminal phalanges of the first, second and third toes and the medial part of the fourth is supplied by branches of the *medial plantar nerve* ; and of the fifth and the lateral part of the fourth by the *lateral plantar nerve.*

Musculo-Cutaneous (Superficial Peroneal) Nerve (L. 4, 5, S. 1).—This is one of the two terminal branches of the lateral popliteal (common peroneal) nerve. It begins on the lateral side of the neck of the fibula, descends between the muscles on the lateral side of the leg, and becomes cutaneous by piercing the deep fascia at the junction of the middle and distal thirds of the leg ; it divides, either at once or shortly afterwards, into a medial and a lateral branch.

The *medial branch* supplies the medial part of the dorsum of the foot and divides into two branches, of which one is distributed to the medial side of the big toe, and the other to the adjacent sides of the second and third toes ; it also gives a communicating twig to the anterior tibial nerve (Fig. 104). The *lateral branch* supplies the intermediate part of the dorsum of the foot, and also divides into two branches, of which one supplies the adjacent sides of the third and fourth toes, and the other, after receiving a twig from the sural nerve, supplies the adjacent sides of the fourth and fifth toes (Fig. 104). The branches of both divisions lie deep to the dorsal venous arch.

Sural Nerve (S. 1, 2).—This nerve arises from the medial popliteal nerve, descends over the gastrocnemius, pierces the deep fascia about half-way down the back of the leg, and is

joined shortly afterwards by the sural communicating branch (L. 5, S. 1, 2) of the lateral popliteal nerve (Fig. 116). It descends behind the lateral malleolus, and then, curving forwards below the malleolus, it runs along the lateral border of the foot to the little toe, giving branches, on its way, to the lateral part of the dorsum of the foot, and communicating with the musculo-cutaneous nerve. After it pierces the deep fascia, it lies alongside the small saphenous vein.

***Dissection.*—Remove the remains of the superficial fascia to display the deep fascia.**

Deep Fascia.—The deep fascia does not form a complete investment for the leg. It is absent over the subcutaneous part of the medial surface of the tibia, and is attached to the anterior and medial borders of that bone. It is absent over the triangular subcutaneous surface of the fibula also, being attached to the borders of that area. It is not equally dense throughout. It becomes thinner towards the distal part of the leg until the region of the ankle is reached, where thickened bands are formed in it; and it becomes exceedingly thin and fine on the dorsum of the foot. Its great strength in the proximal part of the front of the leg is due to the fact that there it gives origin to fibres of the subjacent muscles. The bands in the region of the ankle are called *retinacula*, for their function is to retain the tendons in position, and to form slings for them (see pp. 298, 300), when the muscles which move the joint are in action. A preliminary examination of four of the bands should be made at this stage of the dissection, viz., the two extensor retinacula (p. 298) and the two peroneal retinacula (p. 300).

The *superior extensor retinaculum* is a strong, broad band which stretches across the front of the leg from tibia to fibula, immediately above the ankle joint.

The *inferior extensor retinaculum* is distal to the ankle joint. Laterally, it is fixed firmly to the anterior part of the calcaneus. Medially, it divides into two diverging bands. The upper band is attached to the medial malleolus; the lower band passes to the medial side of the foot, and merges into the deep fascia of the sole. The tendons that are strapped down by the extensor retinacula can be seen through the deep fascia as they emerge from under cover of the inferior retinaculum. From medial to

lateral side they are: tibialis anterior, extensor hallucis longus, extensor digitorum longus and peroneus tertius (Figs. 144, 145).

The two muscles on the lateral side of the leg are called the *peroneus longus* and *peroneus brevis.* Their tendons descend over the back of the lateral malleolus, and then curve forwards below the malleolus. A thickened portion of the deep fascia straps them down on the back of the lateral malleolus, and is called the *superior peroneal retinaculum.* Another band—the *inferior peroneal retinaculum*—straps them down on the lateral surface of the calcaneum (Fig. 149).

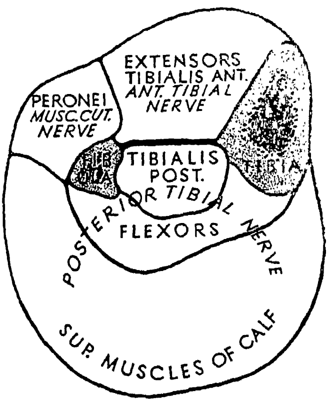


FIG. 141.—Diagram of Osteo-fascial Compartments of Leg.

Intermuscular Septa (Fig. 141).—The deep fascia of the front and the lateral side of the leg sends in septa between the muscles. These septa give partial origin to the muscles; they are seen as white lines in the partially dissected limb, and their positions are indicated by narrow grooves in a thin living limb when the muscles are thrown into contraction.

Two of the septa are longer and stronger than the others, and are called the anterior and posterior intermuscular septa of the leg. The *anterior septum* separates the extensors on the front of the leg from the two peroneal muscles, and it is attached to the anterior border of the fibula. The *posterior septum* is interposed between the peroneal muscles and the muscles on the back of the leg, and is attached to the posterior border of the fibula. The leg is thus subdivided into three osteo-fascial compartments—anterior, lateral and posterior (Fig. 141).

Dissection.—**Remove the deep fascia from the front of the leg; but retain the extensor retinacula by separating them artificially with the knife from the deep fascia with which they are continuous. While thus defining their margins and while removing the deep fascia, take great care not to injure the synovial sheaths of the tendons that lie under cover of them.**

PLATE XXIX

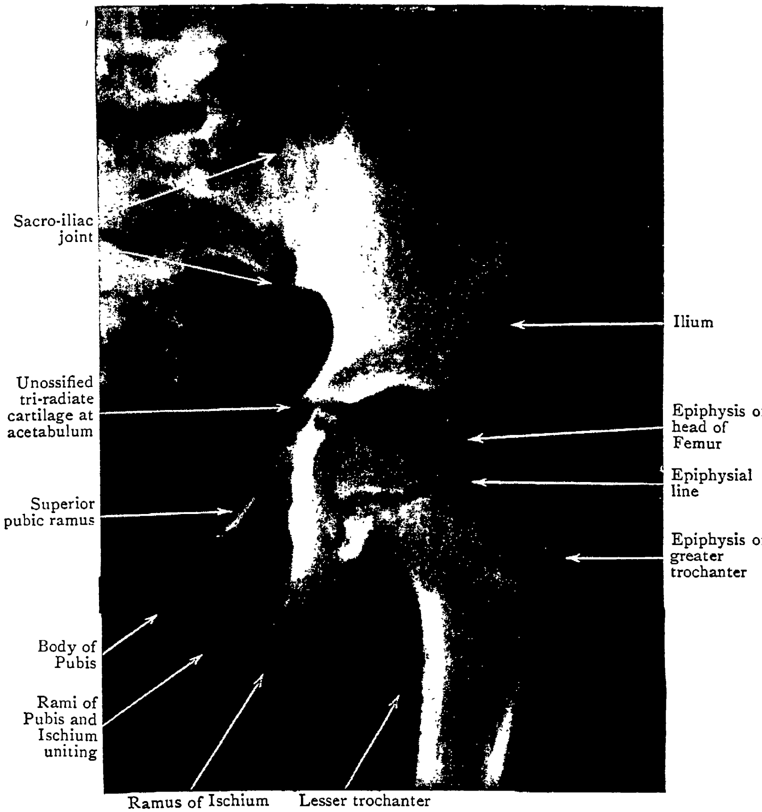


FIG. 142.—Radiograph of Hip of boy aged 7.

The epiphysis of the lesser trochanter of the Femur has not yet appeared.

PLATE XXX

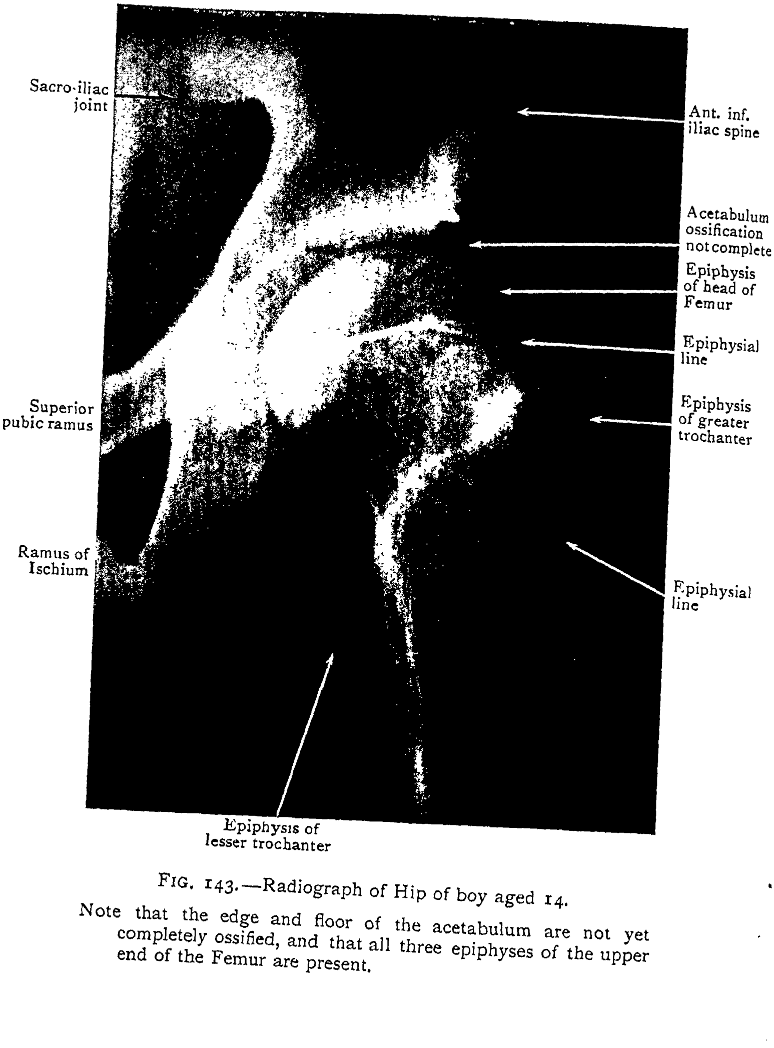


FIG. 143.—Radiograph of Hip of boy aged 14.

Note that the edge and floor of the acetabulum are not yet completely ossified, and that all three epiphyses of the upper end of the Femur are present.

In the proximal part of the leg, leave the deep fascia in position, for it is impossible to raise it from the muscles without lacerating their surfaces. At a lower level, it can readily be separated. Divide it in a longitudinal direction midway between the tibia and fibula. Turn aside the medial piece until its attachment to the tibia is demonstrated ; then, turn aside the lateral piece until its continuity with the anterior intermuscular septum is displayed.

Now, attempt to distend the synovial sheaths of the tendons, either by inflation with air through a blow-pipe or by the injection of some liquid through a small syringe. Three sheaths are to be examined (see below and Fig. 144). Make a small incision through the deep fascia into each sheath in turn, either at the lower border of the inferior retinaculum or between its two bands, and insert the blow-pipe or the needle of the syringe. If inflation or injection fails, examine the extent of the sheaths with a blunt probe.

Synovial Sheaths on Dorsum of Foot.—There are three synovial sheaths in front of the ankle and on the dorsum of the foot—one around the tendon of the *tibialis anterior*, the second around the tendon of the *extensor hallucis longus*, and the third encloses the tendons of the *extensor digitorum longus* and *peroneus tertius*.

The first extends from the upper border of the superior retinaculum to within a short distance of the insertion of the tibialis anterior into the medial cuneiform bone. The second begins between the retinacula, and extends to the first phalanx of the big toe. The third extends from the lower border of the superior retinaculum to the middle of the dorsum of the foot. The sheaths facilitate the movements of the tendons when the muscles are in action; and they are of surgical importance because they are liable to become inflamed.

After the synovial sheaths have been examined, the anterior compartment of the leg may be investigated.

Contents of Anterior Compartment of Leg.—Four muscles are brought into view when the deep fascia of the front of the leg has been removed, viz., the tibialis anterior, the extensor digitorum longus, the extensor hallucis longus, and the peroneus tertius. The *tibialis anterior* lies in relation to the tibia ; the *extensor digitorum longus* is placed along the fibula ; and, when these muscles are separated from each other, the *extensor hallucis longus* will be seen in the interval between them. The *peroneus tertius* lies on the distal portion of the fibula, and is usually continuous with the extensor digitorum longus. The muscles

arise partly from the bones of the leg, but to a large extent they take origin also from the deep fascia and the fascial septa.

The *anterior tibial vessels* and *nerve* descend in this com-

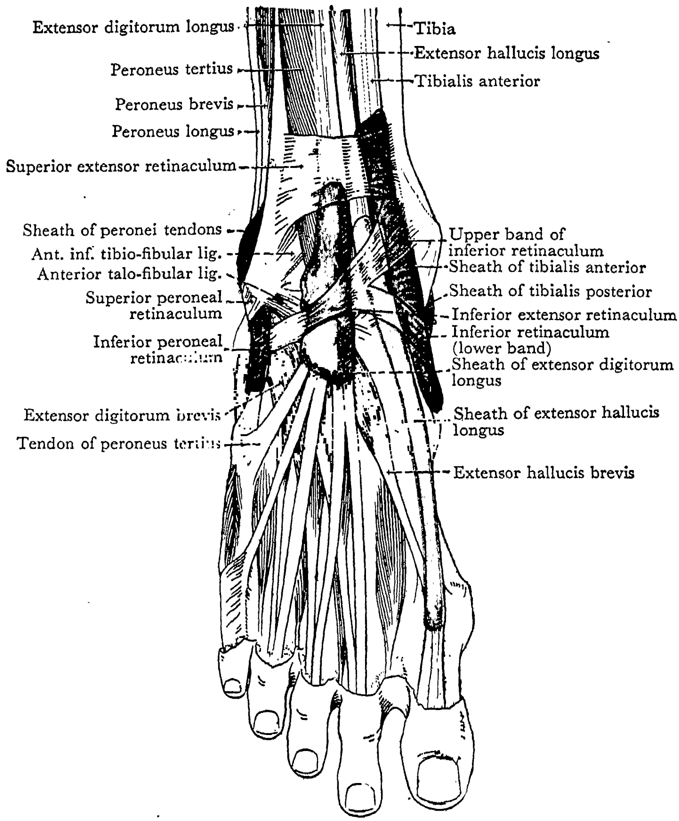


FIG. 144.—Synovial Sheaths of Dorsum of Foot.

partment. At first they are deeply placed, but as they approach the ankle they come nearer to the surface.

Dissection.—To expose the *anterior tibial vessels* and *nerve* in their entire course, separate the tibialis anterior and the extensor digitorum longus from each other by carrying the knife upwards along the septum between them. Draw the

peroneus tertius muscle aside, and find the *perforating branch of the peroneal artery* as it pierces the interosseous membrane and descends into the foot.

As you clean each structure, follow it into the dorsum of the foot and onwards to its termination, clearing away the deep fascia. The *dorsalis pedis* is the continuation of the anterior tibial artery into the foot. Clean it and its branches.

The small muscle on the dorsum of the foot is the *extensor digitorum brevis.* Clean it, and follow its tendons to the toes.

On the second or the third toe, clean the *extensor expansion* formed over the proximal phalanx by the long and short extensor tendons; trace the middle part of the expansion to the base of the middle phalanx and the two outlying parts to the base of the distal phalanx. Define the margins of the expansion and find slender tendons that join the margins; they come from small muscles in the sole—*lumbrical* and *interosseous muscles.*

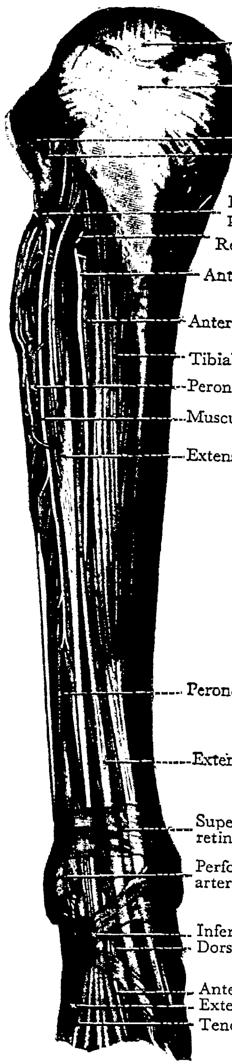


FIG. 145.—Dissection of Front and Lateral Side of Leg.

Tibialis Anterior.—This powerful muscle lies along the

lateral side of the shin and takes origin chiefly from the upper half of the lateral surface of the tibia, and from the interosseous membrane (Fig. 146). A strong tendon issues from its fleshy belly in the distal third of the leg, and reaches the dorsum of the foot by passing through both the extensor retinacula. On the foot, it inclines medially, turns round the medial margin, and gains insertion into the medial side

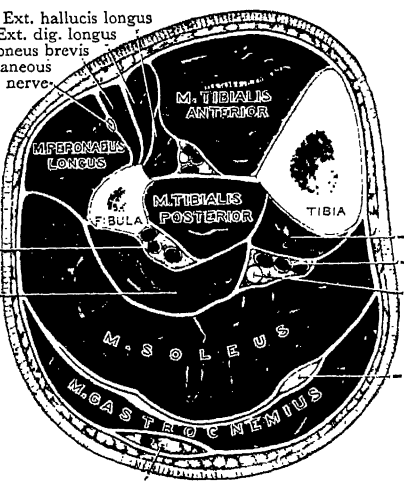


FIG. 146.—Transverse Section through Middle of Leg.

of the medial cuneiform bone near the sole, and into the adjoining part of the base of the first metatarsal bone.

The tibialis anterior is supplied by the *anterior tibial nerve* and the *recurrent genicular nerve.* It is a dorsi-flexor and an invertor of the foot.

Extensor Digitorum Longus.—The extensor digitorum longus is a long, thin sheet of muscle which arises, for the most part, from the upper three-fourths of the anterior surface of the fibula (Figs. 145, 146). Its tendon descends behind the superior extensor retinaculum and in front of the ankle joint; it then passes through the inferior retinaculum (p. 298), and divides into four slips which diverge from one another to reach the lateral four toes, where they are inserted into the

middle and distal phalanges. On the dorsum of the first phalanx of the *second*, *third* and *fourth* toes, each slip is joined, on its lateral side, by a tendon from the extensor digitorum brevis.

On those three toes, the tendons of the long and short extensors unite and form an expansion on the dorsum of the first phalanx. Each expansion divides into a middle part and

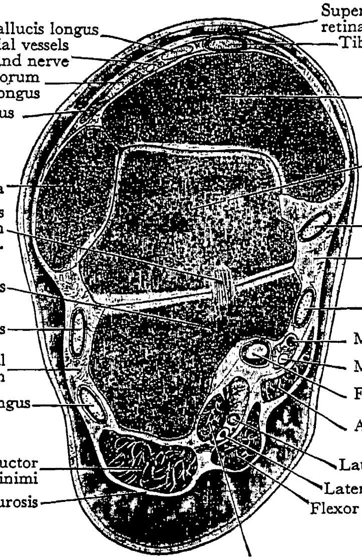


FIG. 147.—Coronal Section through Left Ankle Joint, Talus and Calcaneus

two collateral parts. The middle part is slender and very short, and is inserted into the base of the middle phalanx; the collateral parts are stronger, and unite together to be inserted into the base of the terminal phalanx. The expansions are joined by thin extensions of slender tendons that pass obliquely upwards across the metatarso-phalangeal joints from certain muscles of the sole of the foot, namely the *lumbrical* muscles and the *interosseous* muscles—one lumbrical and two interossei to each expansion. Thus, five

tendons gain insertion into the second and third phalanges of those three toes. The lumbrical and interosseous muscles flex the metatarso-phalangeal joint, and may aid the extensors in extending the interphalangeal joints.

The little toe has only one extensor tendon, but it expands, divides and is inserted in the same way; it is joined by the tendons of one lumbrical and one interosseous muscle.

The extensor digitorum longus is supplied by the *anterior tibial nerve*. It is an extensor of the interphalangeal and metatarso-phalangeal joints of the lateral four toes and it dorsi-flexes the foot.

Peroneus Tertius.—This is a small muscle, not always present; it is continuous at its origin with the extensor digitorum longus, of which it appears to be a separated part. It arises from the distal fourth of the anterior surface of the fibula and from the interosseous membrane, and it ends in a slender tendon which expands to be inserted into the dorsal surface of the base of the fifth metatarsal bone. It is supplied by the *anterior tibial nerve*. It is a dorsi-flexor of the ankle joint and an evertor of the foot.

Extensor Hallucis Longus.—The long extensor of the big toe is a thin muscle placed between the tibialis anterior and the extensor digitorum longus. Its upper part is hidden by those muscles, but it comes to the surface near the ankle. It arises from the middle two-fourths of the anterior surface of the fibula, and also from the interosseous membrane. Its tendon passes deep to the superior retinaculum, crosses in front of the distal part of the anterior tibial artery, and descends in front of the ankle joint into the dorsum of the foot. It then passes through the inferior retinaculum (Fig. 144), and runs onwards to be inserted into the base of the distal phalanx of the big toe, occasionally giving a slip to the base of the proximal phalanx also. The extensor hallucis longus is supplied by the *anterior tibial nerve*. It is an extensor of the phalanges of the big toe and a dorsi-flexor of the foot.

Anterior Tibial (Deep Peroneal) Nerve.—The anterior tibial nerve is one of the two terminal branches of the lateral popliteal (common peroneal) nerve. It arises on the lateral side of the neck of the fibula, under cover of the peroneus longus muscle, and pierces the anterior intermuscular septum and the extensor digitorum longus to enter the anterior compartment of the leg. In that compartment it runs down-

wards to the ankle joint, which it crosses about midway between the malleoli ; and it ends on the dorsum of the foot, near the ankle joint, by dividing into a lateral and a medial branch.

Relations.—In the upper two-thirds of the compartment it lies very deeply between the muscles, having the long extensors on its lateral side and tibialis anterior medial to it ; but in the distal third, where the fleshy bellies give place to tendons, it is nearer the surface. At first the nerve is in front of the interosseous membrane with the anterior tibial vessels on its medial side (Fig. 146) ; it then passes on to the front of the artery ; but, in the distal third of the leg, the nerve lies on the tibia with the vessels on one or other side of it—usually on its medial side again.

The extensor hallucis longus, at first on the lateral side of the nerve, crosses in front of the nerve and vessels just above the ankle to lie medial to them at the ankle, separating them from the tibialis anterior.

On the dorsum of the foot, the nerve lies on the talus, beneath the inferior extensor retinaculum, between the extensor digitorum longus and the extensor hallucis longus.

Branches. — In the leg the anterior tibial nerve gives *muscular branches* to the four muscles ; and a fine *articular twig* to the ankle joint.

The *medial terminal branch* is continued forwards on the dorsum of the foot, under cover of the deep fascia. The extensors of the digits are on its lateral side, but the tendon of the extensor brevis for the big toe crosses it ; the extensor hallucis longus is on the medial side. The dorsalis pedis and first dorsal metatarsal artery are usually between it and extensor hallucis, but may be (as in Fig. 148) on the lateral side of the nerve.

At a variable point in the first interosseous space, it pierces the deep fascia, and divides to supply the contiguous margins of the big toe and the second toe (p. 286). Before it reaches the surface, it furnishes *articular twigs* to the tarso-metatarsal and metatarso-phalangeal joints of the big toe, and frequently also a fine *muscular twig* to the first dorsal interosseous muscle.

The *lateral terminal branch* of the anterior tibial nerve turns abruptly laterally, under cover of the extensor digitorum brevis, and ends on the dorsum of the tarsus in a gangliform enlargement. Branches proceed from the enlargement to

inferior extensor retinaculum, and, as it leaves the dorsum by the extensor hallucis brevis.

Branches. — On the dorsum of the foot, it gives off :— (1) small *tarsal* arteries, (2) the *arcuate* artery, and (3) the *first dorsal metatarsal* artery. Its termination in the sole will be examined later (p. 343).

The **arcuate artery** arises opposite the bases of the metatarsal bones, and runs laterally across them, under cover of the extensor tendons. It sends forwards *three dorsal metatarsal arteries* over the lateral three spaces, each of which divides into two *dorsal digital arteries* for contiguous sides of the toes, and the lateral one sends a twig to the lateral side of the little toe.

The **first dorsal metatarsal artery** arises at the point where the dorsalis pedis dips towards the sole. It runs forwards over the first dorsal interosseous muscle, and divides into *dorsal digital branches* for the medial side of the big toe and the adjacent sides of the big toe and second toe.

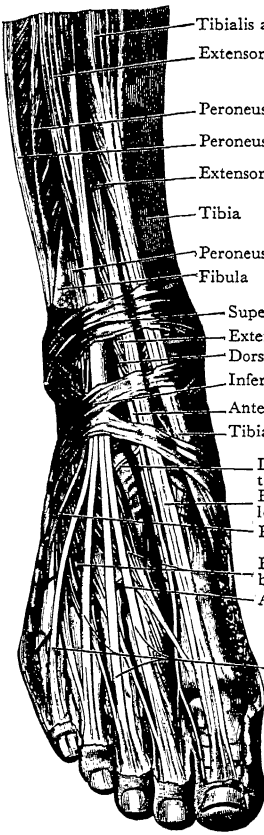


FIG. 148.—Dissection of Dorsum of Foot.

Extensor Digitorum Brevis.—The short extensor of the toes forms a fleshy cushion on the dorsum of the foot, and is supplied by the lateral branch of the *anterior tibial nerve*. It arises from the anterior part of the dorsal surface of the calcaneus, and also from the stem of the inferior extensor retinaculum. The muscular mass breaks up into four segments.

The most medial of the four is called the **extensor hallucis brevis.** It ends in a tendon which crosses the distal part of the dorsalis pedis artery, and is inserted into the base of the proximal phalanx of the big toe. It is an extensor of the first metatarso-phalangeal joint.

The remaining three segments end in tendons which join the long extensor tendons for the second, third and fourth toes, and, by means of the extensor expansions (see p. 293), they gain insertion into the middle and terminal phalanges of those toes. They act as extensors of the inter-phalangeal and metatarso-phalangeal joints.

Extensor Retinacula.—The dissector should now re-examine the extensor retinacula, and the arrangement of the structures which pass deep to them and through them. They are two thickenings of the deep fascia which strap down the tendons of the tibialis anterior, the peroneus tertius and the long extensors, and prevent them from springing away when the muscles contract. They are distinguishable from the adjoining deep fascia only by their greater thickness, and have to be artificially separated from it by dissection (Figs. 144, 148, 149).

The **superior extensor retinaculum** is a strong band, an inch or more in width from above downwards, situated immediately above the ankle joint. Its ends are firmly attached to the anterior borders of the tibia and the fibula. The long extensors, the peroneus tertius and the anterior tibial vessels and nerve pass behind it; but its medial part splits to enclose the tendon of the tibialis anterior and its synovial sheath, forming a kind of sling for that tendon. To make certain of these points, divide the fibular attachment of the retinaculum, and pull it towards the tibial side.

The **inferior extensor retinaculum** is the more important of the two. It is shaped like the letter Y placed on its side, and lies across the dorsum of the foot close to the ankle joint. The stem of the Y is the lateral part of the ligament. It is firmly attached to the anterior part of the upper surface of the calcaneus. Its deep surface gives partial origin to the extensor digitorum brevis, and is connected with the strong, interosseous ligament that binds the calcaneus and the talus together. Traced medially, the stem divides into two diverging bands. The upper band inclines upwards to be attached to the anterior margin of the medial malleolus. The lower

band passes to the medial side of the foot, and, blending with the deep fascia there, becomes indistinct, but may be traced into the deep fascia of the sole of the foot.

The deep surface of the retinaculum is adherent to the tarsal bones and ligaments, except where the dorsalis pedis vessels and anterior tibial nerve pass under cover of it; but in three places it is split into two layers for the passage of tendons and their synovial sheaths:—(1) in the medial part of the stem, for the extensor digitorum longus and the peroneus tertius; (2) in both arms of the Y, for the extensor hallucis longus; and (3) more medially in both arms, for the tibialis anterior; the layer that overlies the tibialis anterior is sometimes very thin.

Lateral Side of Leg

Before the lateral osteo-fascial compartment of the leg is opened up, note the course of the tendons of the peroneus longus and brevis and examine their retinacula and their synovial sheath.

The **peroneal tendons** descend behind the lateral malleolus—the longus lying superficial to the brevis—and are bound down by the thickened portion of the deep fascia called the superior peroneal retinaculum. They then curve forwards, below the malleolus, over the lateral surface of the calcaneus and are held in contact with it by the inferior peroneal retinaculum. The peroneus brevis passes to its insertion into the base of the fifth metatarsal bone. The peroneus longus runs forwards below the brevis and is separated from the brevis by the peroneal trochlea of the calcaneus; and it disappears into the sole behind the base of the metatarsal bone.

The **synovial sheath** begins about two inches above the tip of the lateral malleolus, and is at first a single sheath that envelops both tendons; but on the lateral surface of the calcaneus it divides into two sheaths. The sheath of the peroneus brevis envelops it almost to its insertion. The sheath of the longus follows it across the sole to its insertion, but is often interrupted at the lateral side of the foot.

Dissection.—Identify the upper margin of the superior retinaculum. Remove the deep fascia immediately above it very carefully, and expose the *synovial sheath*. Pinch up the sheath and either inflate it or inject it in the way described on

p. 289. If that fails, expose the peroneal tendons between the two retinacula, and examine the extent and subdivisions of the sheath with a blunt probe. Then, clean the *retinacula*, and define their borders and connexions.

Peroneal Retinacula.—These bands are the thickened portions of the deep fascia that prevent displacement of the peroneal tendons. They are not so sharply marked off from the adjacent fascia as the extensor retinacula are, and require more careful dissection for their definition.

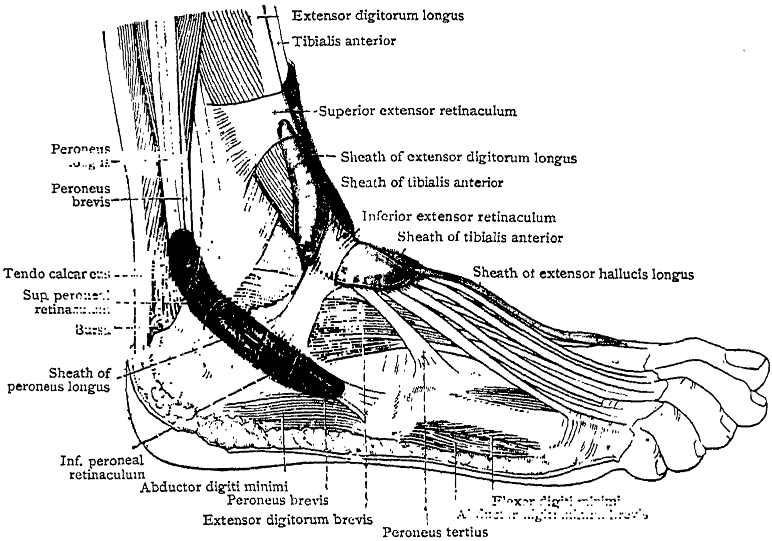


FIG. 149.—Dissection showing Synovial Sheaths of Tendons of Foot.

The **superior peroneal retinaculum** bridges over the peroneal tendons as they lie on the back of the lateral malleolus. It is attached to the back of the lateral malleolus and to the lateral surface of the calcaneus; and it is connected also with the layer of fascia that lies deeply in the back of the leg. It is lined with the common synovial sheath of the peronei.

The **inferior peroneal retinaculum** lies across the peroneal tendons when they reach the lateral surface of the calcaneus. Superiorly, it is attached to the anterior part of the upper surface of the calcaneus, and is continuous there with the stem of the inferior extensor retinaculum. Inferiorly,

it is attached to the lateral surface of the calcaneus below the peroneal tendons. It sends in a septum which is attached to the calcaneus between the tendons; each tendon, therefore, lies in a separate tunnel, which is lined with the branch of the synovial sheath that envelops the tendon.

Dissection.—Open up the lateral compartment of the leg to display its contents. Divide the deep fascia over the peroneal muscles by a longitudinal incision, and turn the flaps aside until their continuity with the intermuscular septa is demonstrated, but do not injure the peroneal retinacula.

Next, separate the two *peroneal muscles* from each other; clean them, and secure their nerves of supply. Then, cut through the upper part of the peroneus longus in order to find the terminal part of the lateral popliteal nerve; trace its *recurrent genicular branch* upwards, and the *musculo-cutaneous nerve* downwards.

PERONEAL MUSCLES.—The peroneus longus and brevis are separated from the extensors by the anterior intermuscular septum and from the muscles of the calf by the posterior septum. The peroneus longus reaches up to the head of the fibula; the peroneus brevis is in front of the longus, but reaches up only to the junction of middle and upper thirds of the fibula. They arise partly from the fibula, but most of their fibres spring from the intermuscular septa and the deep fascia that covers them. They are evertors of the foot, and, to some extent, plantar-flexors; and they are supplied by the *musculo-cutaneous nerve*.

Peroneus Longus.—The peroneus longus muscle arises from the upper two-thirds of the lateral surface of the fibula. Its tendon begins a short distance above the ankle, descends behind the lateral malleolus, and curves forwards below it; the tendon then runs over the lateral surface of the calcaneus to the lateral border of the foot behind the base of the fifth metatarsal bone, where it enters the groove on the plantar surface of the cuboid bone; in that groove, it runs obliquely across the sole of the foot to be inserted into the base of the first metatarsal bone and into the adjoining part of the medial cuneiform bone. Its position in the sole will be examined later.

Peroneus Brevis.—This muscle arises from the lower two-thirds of the lateral surface of the shaft of the fibula, overlapping the peroneus longus in the middle third. Its tendon descends over the back of the lateral malleolus, under cover of the peroneus longus, and then turns forwards, on the

lateral surface of the calcaneus, above the longus, to gain insertion into the tuberosity on the base of the fifth metatarsal bone. Occasionally, it sends forwards a slender slip to join the extensor tendon of the little toe.

The **peroneus tertius** (p. 294), which acts with the other peroneal muscles in eversion of the foot, is a separated slip of the extensor digitorum longus and is supplied by the anterior tibial nerve.

TERMINAL BRANCHES OF LATERAL POPLITEAL (COMMON PERONEAL) NERVE.—The lateral popliteal nerve has been traced as far as the neck of the fibula. At that point it disappears by passing forwards between the peroneus longus muscle and the bone. As it lies between them, it gives off a small *recurrent genicular branch* to the knee joint, and then divides into the *anterior tibial* (*deep peroneal*) and *musculo-cutaneous* (*superficial peroneal*) *nerves*.

The *recurrent branch* pierces the extensor digitorum longus, and then accompanies the anterior tibial recurrent artery through the upper part of the tibialis anterior (which it supplies) to reach the capsule of the knee joint; it gives a branch also to the superior tibio-fibular joint.

The *anterior tibial nerve* pierces the extensor digitorum longus to reach the anterior compartment of the leg, where it has already been dissected.

Musculo-Cutaneous (Superficial Peroneal) Nerve (L. 4, 5, S. 1).—The musculo-cutaneous nerve descends in the substance of the peroneus longus till it reaches the peroneus brevis, and, for a short distance, lies between these two muscles; it then passes obliquely over the anterior border of the brevis and descends, under cover of the deep fascia, in the groove between the peroneus brevis and the extensor digitorum longus. In the distal third of the leg, it pierces the deep fascia, and divides into a medial and a lateral branch, which descend into the foot (p. 286).

As it traverses the peroneus longus, it gives off branches to both longus and brevis. Its two terminal branches supply the skin of the lower part of the front of the leg, nearly the whole of the dorsum of the foot, and most of the toes.

MEDIAL SIDE OF LEG

This region corresponds to the medial surface of the tibia, most of which is covered only with the skin and the superficial

fascia, for the deep fascia blends with the periosteum at the borders of the bone—except in the upper part, where a thin layer of deep fascia covers the expanded tendons that overlie the bone, namely, sartorius, gracilis and semitendinosus.

Dissection.—The distal parts of the *great saphenous vein* and the *saphenous nerve* have already been cleaned. Now, trace them to the knee. Clean the *tendons* of *sartorius, gracilis* and *semitendinosus*, examine their attachments and throw them forwards; examine the *bursæ* between them and under cover of them. The deeper bursa overlies the *medial ligament of the knee*; and, as the bursa has probably been opened, the surface of the ligament is smooth and glistening. Clean the ligament from end to end; define its borders; and clean the *articular vessels* and *nerve* that pass under cover of it.

The *great saphenous vein* and the *saphenous nerve* will be studied later (pp. 304, 305). The insertions of the *sartorius, gracilis* and *semitendinosus* and their *bursæ* have been described already (p. 260).

The *medial ligament of the knee* is under cover of the sartorius, gracilis and semitendinosus, and separated from them by a bursa. The tendon of the *semimembranosus*, at its insertion into the tibial condyle, is partly under cover of the ligament, which is described with the knee joint (p. 350).

Back of Leg

This is an extensive dissection that includes the superficial muscles of the calf, inserted into the bone of the heel by the tendo calcaneus, and the deep flexor muscles whose tendons pass into the sole of the foot on the medial side of the ankle with the posterior tibial nerve and vessels.

Dissection.—Lay the limb on its anterior surface. Make the muscles of the calf tense by dorsi-flexing the foot, and keep it in that position by chains and hooks fastened to the toes and to the under surface of the table.

Reflexion of Skin.—The skin has already been reflected from the front as far as the medial and lateral borders of the leg and foot. Now, make a transverse incision across the distal part of the heel and carry the extremities of the incision forwards along the medial and lateral borders of the foot; then, remove the skin from the whole of the back of the leg, avoiding injury to the superficial veins and nerves.

Superficial Fascia.—The superficial fascia of the back of the leg presents no special or peculiar features; but it

contains parts of the two saphenous veins and a number of cutaneous nerves.

Dissection.—Complete the cleaning of the *great saphenous vein* and the *saphenous nerve* on the medial side of the knee, if that has not been done already.

Trace the posterior branch of the *medial cutaneous nerve of the thigh* downwards over the medial part of the calf (Fig. 150); and the *posterior cutaneous nerve of the thigh* downwards over the middle of the calf.

The upper part of the *small saphenous vein* has been found in the popliteal fossa, and its lower part on the lateral border of the foot; now, clean the intervening part.

Find the *sural nerve* again where it lies alongside the lower part of the small saphenous vein. Follow it upwards to the point where it pierces the deep fascia; then, trace it upwards to its origin from the medial popliteal nerve, incising the deep fascia to expose it. Two or three inches above the heel it is joined by the *sural communicating nerve*. Follow that nerve upwards to the point where it pierces the deep fascia, and then onwards to its origin from the lateral popliteal nerve.

Look for the *medial calcanean nerves* in the fascia at the medial side of the heel. They are small and difficult to find. The small arteries, if injected, are guides to them.

At this stage the dissector should revise the saphenous veins and the cutaneous nerves which have been seen in previous dissections, but are now, for the first time, displayed from beginning to end (Figs. 104, 150-154).

Great Saphenous Vein.—This is the longest vein in the body. It begins at the medial border of the foot by the union of the dorsal venous arch with the medial digital vein of the big toe. It ascends in front of the medial malleolus, passes obliquely upwards and backwards across the medial surface of the distal third of the tibia, and then vertically upwards, along the medial border of the tibia, to the posterior part of the medial side of the knee. Thence, it passes obliquely upwards, forwards and laterally, through the superficial fascia of the front of the thigh, to the saphenous opening, where it pierces the cribriform fascia and the femoral sheath and terminates in the femoral vein (Figs. 101, 104, 109).

In addition to the veins of origin and the three veins which it receives just before it pierces the cribriform fascia, it receives, during its course, numerous unnamed tributaries. Further, it forms numerous communications with the deep veins of the limb by means of anastomosing channels which pierce the deep fascia.

The great saphenous vein contains a number of valves;

PLATE XXXI

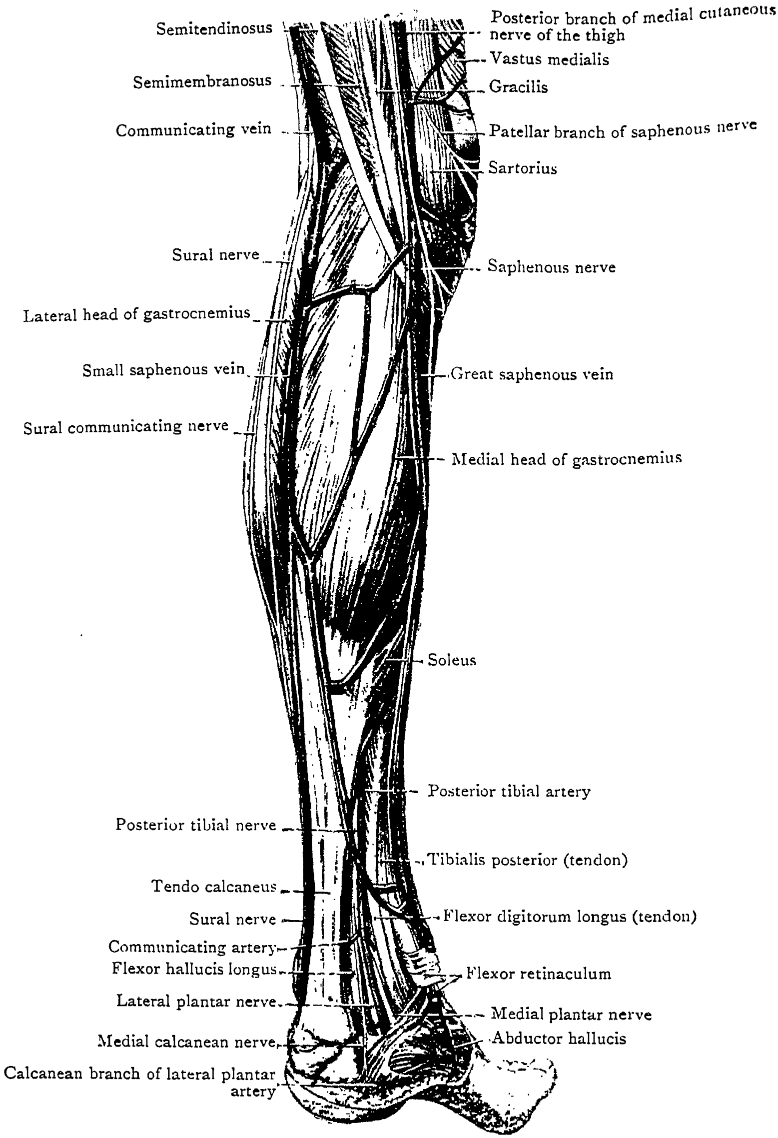


FIG. 150.—Superficial Dissection of Leg viewed from back and medial side, showing Veins and Nerves.

Note the numerous anastomoses between the Great and the Small Saphenous Veins.

[*Facing p.* 304

PLATE XXXII

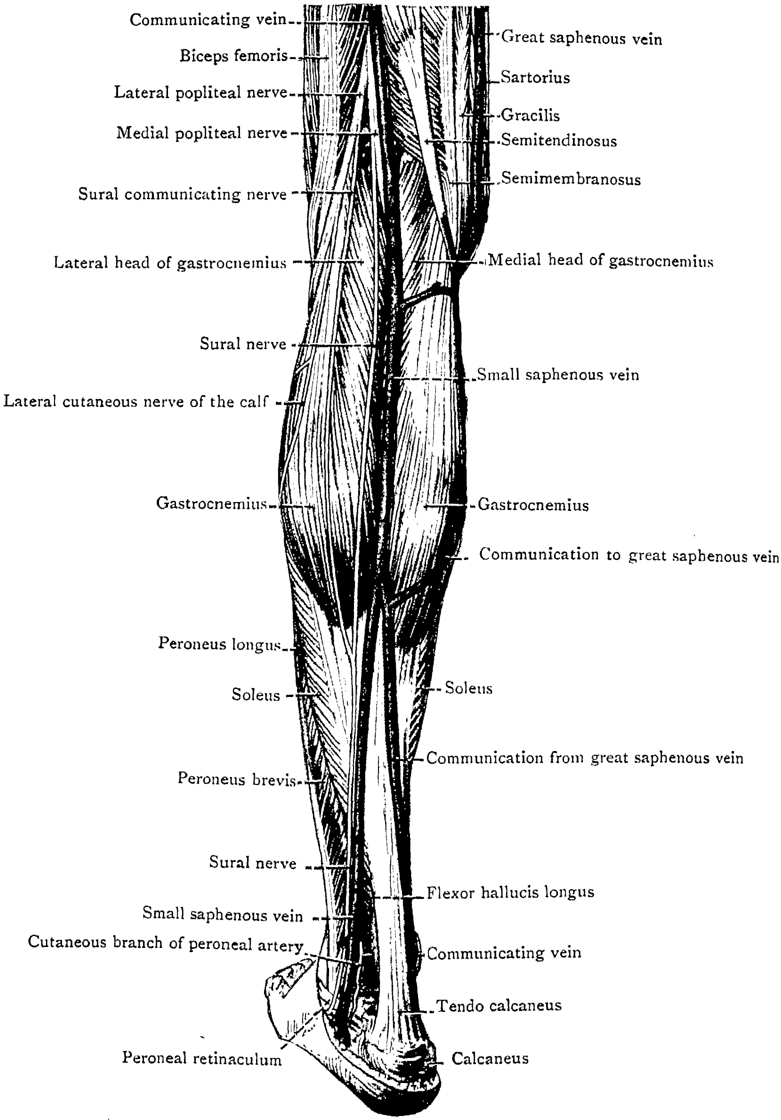


FIG. 151.—Superficial Dissection of Leg viewed from back and lateral side, showing Veins and Nerves.

In the specimen there were numerous large anastomosing channels between the Small and the Great Saphenous Veins.

they partially divide the long column of blood into a series of segments, and so diminish the pressure on the walls of the more distal parts of the vein. But the superficial veins of the leg are often varicose; and in that condition the valves are incompetent.

Small Saphenous Vein.—The small saphenous vein is formed, in the lateral border of the foot, by the union of the lateral dorsal digital vein of the little toe with the lateral end of the dorsal venous arch. From its point of commencement, it runs backwards below the lateral malleolus, and then upwards behind it into the leg. There, it ascends a little lateral to the tendo calcaneus at first, and then along the middle line of the calf to the lower part of the popliteal region, where it pierces the popliteal fascia and terminates in the popliteal vein.

The small saphenous vein receives tributaries from the lateral border of the foot, the heel and the back of the leg.

The two saphenous veins are connected together by a fairly large vein which springs from the small saphenous vein immediately before it pierces the deep fascia, and terminates in the great saphenous vein above the middle of the thigh. This vein sometimes forms the direct continuation of the small saphenous vein; and the small saphenous has then either only a very small connexion with the popliteal vein, or no connexion with it at all.

Saphenous Nerve.—The saphenous nerve (L. 3, 4) is the longest branch of the femoral nerve. It arises about an inch below the inguinal ligament, and descends, in the femoral triangle, along the lateral border of the femoral artery; it accompanies the artery through the adductor canal, leaves the canal by passing behind the lower edge of its fibrous roof, and then lies directly under cover of the sartorius. It escapes from under cover of the sartorius at the posterior border of the muscle—between the sartorius and the tendon of the gracilis—a little above the knee. It then descends along the posterior part of the medial side of the knee, where it pierces the deep fascia and enters the leg. In the leg, it accompanies the great saphenous vein first along the medial border of the tibia, and then obliquely forwards across the distal third of the tibia. It enters the foot by passing downwards in front of the medial malleolus—still in company with the vein—and it ends in the skin at the middle of the medial border of the foot. After it leaves

the adductor canal, and before it emerges between the sartorius and gracilis, it gives off an *infrapatellar branch* (Fig. 104, p. 202), which pierces the sartorius on its way to the patellar plexus. Beyond the knee, its branches are distributed to the skin of the medial side of the leg and foot.

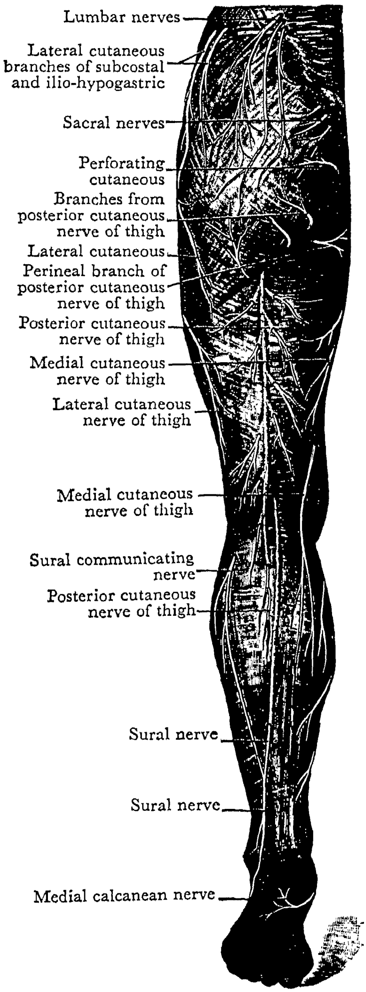


FIG. 152.—Cutaneous Nerves on Back of Lower Limb. See also Fig. 104, p. 202.

Sural Nerve.—This nerve (S. 1, 2) arises in the popliteal fossa from the medial popliteal nerve, descends in the groove between the two heads of the gastrocnemius, pierces the deep fascia of the leg about midway between the knee and the ankle, and accompanies the small saphenous vein into the foot—descending to the back of the lateral malleolus, and then forwards along the lateral border of the foot and onwards to the end of the little toe.

Shortly after it pierces the deep fascia, it is joined by the sural communicating nerve; on the side of the foot it gives a communicating twig to the branch of the musculo-cutaneous nerve destined for the contiguous sides of the fourth and fifth toes. It supplies the skin of the lower, lateral part of the back of the leg, the lateral border of the foot and

adjoining part of the dorsum, and the lateral side of the little toe.

Sural Communicating Nerve (L. 5, S. 1, 2).—This nerve arises in the popliteal fossa from the lateral popliteal nerve, frequently in common with the *lateral cutaneous nerve of the calf* (p. 255). It crosses superficial to the lateral head of the gastrocnemius, where, as a rule, it pierces the deep fascia ; it then passes downwards and medially to the upper end of the lateral border of the tendo calcaneus, where it joins the sural nerve. It supplies the skin of the proximal two-thirds of the back of the leg.

Medial Cutaneous Nerve of Thigh (L. 2, 3).—The origin and distribution of this nerve, a branch of the femoral, have been described on pp. 202, 220. Its *posterior branch* pierces the deep fascia a little above the knee, behind the sartorius and the great saphenous vein, and descends to supply the skin of the upper part of the medial side of the leg.

The *posterior cutaneous nerve of the thigh*, and the *lateral cutaneous nerve of the calf* have been sufficiently described already (see pp. 255, 258, 286).

Lymph-Vessels and Lymph-Nodes of Lower Limb.—In an ordinary dissecting-room subject, it is impossible to display the lymph-vessels of the limb in a satisfactory manner. The dissectors will have seen the inguinal lymph-nodes, and may have found one or two of the popliteal group, but they will not have been able to trace the lymph-vessels except for a short distance from the nodes in the groin. They should, however, at this point, study the general arrangement of the lymph-nodes and lymph-vessels of the limb, noting, as in the case of the Upper Limb, their general relation to the pattern of the main veins.

As in other parts of the body, there are superficial and deep groups of both nodes and vessels.

The **superficial lymph-nodes** are the superficial inguinal nodes, and they are in two groups—upper and lower (p. 196).

The **deep lymph-nodes** are related to the main blood-vessels. They are :—The deep inguinal nodes (p. 213), the popliteal nodes (p. 251), and a single anterior tibial node which lies close to the anterior tibial artery in the upper part of the front of the leg.

The **deep lymph-vessels** are much less numerous than the superficial vessels, though they drain all the structures that lie deep to the deep fascia. They run along the principal blood-vessels, and most of them end in the deep inguinal nodes—the exception being those from the deep parts of the gluteal region and upper part of back of thigh, which accompany the gluteal vessels into the pelvis and end in the internal iliac nodes. Those from the leg are interrupted in the popliteal nodes; and the anterior tibial node is placed in the path of those that run along the anterior tibial vessels.

The **superficial lymph-vessels** collect the lymph from the skin and the subcutaneous tissues. They all ultimately reach the deep inguinal lymph-nodes ; and their paths are determined by their tendency to converge upon two main streams. Thus : far more of the vessels of the foot ascend in front of the ankle than behind it, and most of them—and many others from the leg and thigh—converge upon the great

saphenous vein, and follow it to the superficial inguinal nodes; the remainder—a small number from a relatively limited area of foot and leg — follow the small saphenous vein to the popliteal nodes.

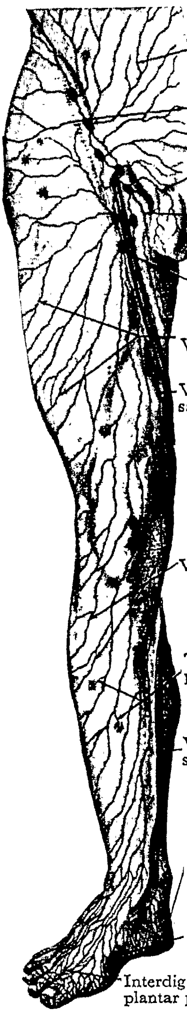


FIG. 153.—Superficial Lymph-Vessels of Front of Lower Limb.

In the sole of the foot, as in the palm of the hand, there is a dense cutaneous plexus of lymph-capillaries, and the origin of the lymph-vessels from the plexus resembles that of the hand (p. 75); but the great projection of the heel causes a slightly different orientation of the vessels as they leave the foot. The vessels from the lateral border of the foot, from the back of the heel, and from part of the back of the leg (Fig. 154) accompany the small saphenous vein to the popliteal nodes. The vessels from the distal parts of the plantar surfaces of the toes pass to the dorsum of the foot at the interdigital clefts. Then, together with vessels that arise from the plantar capillary plexus, and from the dorsum and medial border of the foot, they ascend across the front of the ankle and the medial malleolus, and constitute the main stream along the line of the great saphenous vein. They are joined by vessels from the front and medial side of the leg, and from the medial side and greater part of the front of the thigh; and all these vessels end in the lower group of superficial inguinal nodes. The vessels from the upper part of the front of the thigh, the back of the thigh and the gluteal region converge upon the upper group of superficial inguinal nodes, to which vessels proceed also from the perineum and the lower

part of the anterior wall of the abdomen. The efferents from these nodes pass to the deep inguinal nodes.

It follows from what has been said that, with the exception of the lymph from the deep parts of the gluteal region and back of thigh, all the lymph of the lower limb passes through the deep inguinal nodes; and it may be noted, further, that the efferent vessels from these nodes pass to the external iliac nodes in the abdomen immediately above the inguinal ligament, whence the lymph is carried onwards, through the common iliac nodes and the lumbar nodes, to the lumbar lymph-trunks.

The student should compare the arrangement of the lymph-vessels of the Lower and Upper Limbs (pp. 75-76). He should note, in particular, the manner in which the superficial lymph-vessels of each limb converge upon the important groups of lymph-nodes at the roots of the limbs (armpit and groin), and that these groups receive also the superficial vessels of the trunk, and thus share a very wide territory between them.

The lymph-vessels begin in a similar manner in the hand and in the foot; and, in each limb, two streams are formed—a chief and a subsidiary—each associated with a vein. The chief stream in the lower limb follows the great saphenous vein to the nodes in the groin, which, though mainly superficial, correspond to the nodes in the axilla. The subsidiary stream in the lower limb follows the small saphenous vein to the nodes in the popliteal fossa. These popliteal nodes correspond to the nodes at the bifurcation of the brachia artery *plus* the superficial cubital nodes; the lymph-vessels that follow the small saphenous vein correspond.

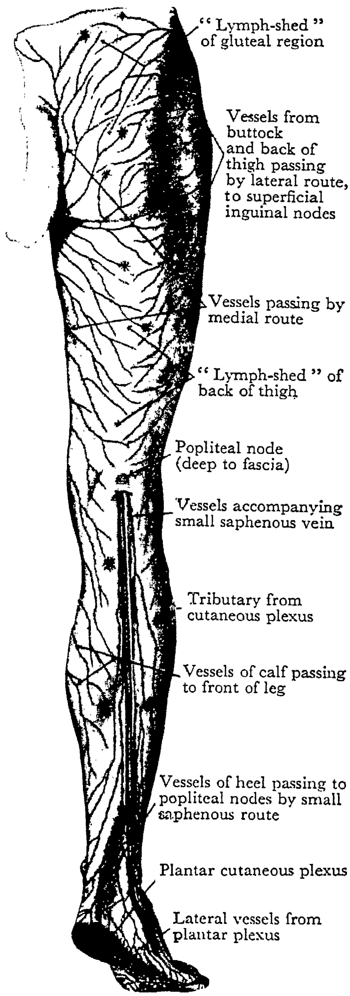


FIG. 154.—Superficial Lymph-Vessels of Back of Lower Limb.

therefore, to those of the upper limb that pierce the deep fascia with the basilic vein.

***Dissection.*—Remove the remains of the superficial fascia from the back of the leg, and clean the deep fascia.**

Deep Fascia.—In the proximal part of the calf, the deep fascia is thin and transparent; it thickens considerably as the heel is approached. On the lateral side of the ankle, it is thickened to form the *superior peroneal retinaculum* (p. 300). On the medial side, it is greatly strengthened to form a broad band which bridges across the interval between the calcaneus and the medial malleolus, and is called the *flexor retinaculum* because it straps down the tendons of the long flexors of the toes and the tibialis posterior and retains them in place as they pass from the back of the leg into the foot.

The deep fascia is continuous proximally with the popliteal fascia. On the medial side, it is attached to the medial border of the tibia, where it blends with the periosteum, and on the lateral side it joins the posterior intermuscular septum, by which it is attached to the posterior border of the fibula (Figs. 141, 146). Thus, the deep fascia forms the posterior boundary of the posterior osteo-fascial compartment of the leg.

Posterior Osteo-Fascial Compartment of Leg.—This great compartment is bounded *posteriorly and at the sides* by the investing deep fascia, and *anteriorly* by the tibia, the interosseous membrane, the fibula and the posterior intermuscular septum (Fig. 141, p. 288). Two strong fascial septa stretch across the compartment and divide it into three sections.

The **first septum** is a fairly thick fascial membrane that extends across from the medial border of the tibia to the posterior border of the fibula; it covers the long flexors of the toes and the posterior tibial vessels and separates them from the superficial muscles of the calf (Fig. 146).

Inferiorly, where it has important connexions, it underlies the tendo calcaneus; on the lateral side, it helps the investing fascia to form the superior peroneal retinaculum; and, on the medial side, it is continued into the flexor retinaculum and constitutes the greater part of its thickness.

Superiorly, it is attached to the soleal line of the tibia and to the back of the fibula below the origin of the soleus muscle. Between those attachments, it is continuous, in front of the popliteal vessels, with the fascia of the popliteus muscle; and

it is thickened behind them to form a fibro-tendinous arch which gives partial origin to the soleus muscle.

The **second septum** covers the tibialis posterior. It is attached, medially, to the proximal part of the soleal line of the tibia and to the vertical ridge on the posterior surface of the tibia, and, laterally, to the medial crest of the fibula. Above, it blends with the interosseous membrane; inferiorly, it fuses with the deep surface of the first septum in the distal part of the leg.

The dissector will now proceed to expose the contents of the three sections of the posterior osteo-fascial compartment.

***Dissection.*—First, clean the *flexor retinaculum* carefully, and secure the *medial calcanean arteries* and *nerves*, which pierce it. Note that it is continuous proximally with the deep fascia of the back of the leg, and that distally it gives attachment to a muscle called the abductor hallucis. Then, make a longitudinal incision through the deep fascia, down the middle of the back of the leg, from the popliteal region to the calcaneus. Turn the two flaps to the sides, detaching their distal parts from the retinacula.**

Next, clean the gastrocnemius and the tendo calcaneus; and remove the pad of fat that separates the tendon from the first fascial septum.

If the medial head of the gastrocnemius was not divided when the popliteal fossa was dissected, divide it now at the level of the knee joint, and turn it laterally; then, clean the lower muscular branches of the popliteal artery and the nerves which supply the gastrocnemius, noting the large size of the arteries that enter with them.

Raise the proximal part of the divided head, and note the bursa which intervenes between it and the semimembranosus.

Next, follow the nerve to the soleus, which was found when the popliteal fossa was dissected (see p. 253). Lastly, clean the plantaris, and follow its slender tendon to its insertion.

SUPERFICIAL MUSCLES.—The superficial muscles of the calf of the leg are three in number, viz., the gastrocnemius, the plantaris and the soleus. The gastrocnemius is the most superficial; the soleus is deepest; and the tendon of the plantaris runs downwards and medially between them. The tendons of the gastrocnemius and soleus unite to form the tendo calcaneus.

Gastrocnemius.—The gastrocnemius is a strong muscle. It arises from the distal end of the femur by two heads, already seen bounding the distal part of the popliteal fossa. The *lateral head* springs from an impression on the lateral surface of the lateral condyle of the femur. The *medial head* takes origin from a rough, raised area on the popliteal surface of the femur above the medial condyle.

Each head arises from the bone mainly by a tendon which

spreads out over its superficial surface and gives origin to the short fibres of the muscle-belly. The two fleshy bellies thus swell out as they descend, and near the middle of the leg they end in a thin, aponeurotic tendon, which runs up on the deep surface of each. They do not blend with each other, but are separated by a furrow in which the sural nerve and the small saphenous vein lie. The medial belly is slightly larger and extends a little lower than the lateral belly (Figs.

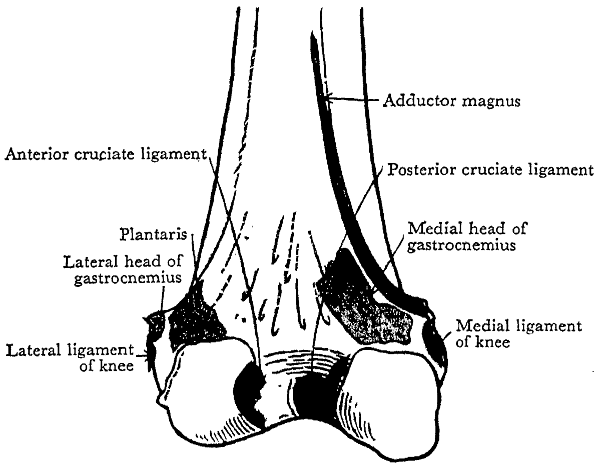


FIG. 155.—Distal part of Back of Femur, with Attachments of Muscles mapped out.

150, 151)—a feature that is sometimes conspicuous in the well-developed calf of a living limb.

The medial head is separated from the back of the capsule of the knee joint by a *bursa* which may communicate with the cavity of the joint and with the semimembranosus bursa. The lateral head often contains a small sesamoid bone (the "fabella") opposite the lateral condyle (Fig. 172); and occasionally it is separated by a bursa from the capsule of the knee joint. The common tendon of the two heads joins the tendon of the soleus to form the tendo calcaneus a short distance below the middle of the leg.

The gastrocnemius is supplied by the *medial popliteal nerve*, each head having a well-marked neuro-vascular hilum

(p. 12). With the soleus, it is a powerful plantar flexor of the foot that comes into action in maintaining the standing position and in providing the necessary impetus for walking. The origins from the femur imply that it may act also as a flexor of the knee, and it does so act to assist the hamstrings against resistance; but the two actions cannot be carried out efficiently at the same time. The action at the knee joint is important after supracondylar fracture of the femur; the gastrocnemius rotates the broken fragment backwards, and treatment is therefore carried out with the knee bent to relax the muscle.

Plantaris.—The plantaris has a small, fleshy belly—not more than three or four inches long. It lies along the medial side of the lateral head of the gastrocnemius and partly under cover of it. It arises from the popliteal surface of the femur immediately above the lateral condyle. It ends in a slender tendon which is remarkable for its great length. The tendon proceeds downwards and medially, between the gastrocnemius and soleus, and then runs along the medial side of the tendo calcaneus to gain insertion into the calcaneus. It is frequently closely connected with the tendo calcaneus, and sometimes becomes blended with it, or with the fascia of the leg.

The plantaris is supplied by a branch from the *medial popliteal nerve*. It is associated in its action with the gastrocnemius; and its chief importance is that its tendon is sometimes ruptured during violent exercise. Like the palmaris longus in the forearm, the muscle is occasionally absent.

***Dissection.*—Divide the lateral head of the gastrocnemius at the level of the knee joint. Turn the proximal part upwards, and examine it to see if it contains a sesamoid bone; then, look for a bursa which is occasionally present between it and the capsule of the knee joint. Turn the distal part downwards and note the manner in which the two heads join their common aponeurotic tendon, and the union of that tendon with the tendon of the soleus.**

Now, clean the posterior surface of the soleus, and define its origin. Note that some of its fibres pass directly to the deep surface of the tendo calcaneus.

Soleus.—The soleus is a flat, thick and powerful muscle which arises from both bones of the leg, and also from a strong fibro-tendinous arch across the lowest part of the popliteal vessels. Its *fibular origin* is from the back of the

head and the upper third of the posterior surface of the shaft; by its *tibial origin* it is attached to the soleal line and the middle third of the medial border of the tibia (Fig. 157). The soleus ends in a strong, stout tendon which joins with the tendon of the gastrocnemius to form the tendo calcaneus. Branches enter the soleus on its superficial surface at its upper end from the *medial popliteal nerve*, and on its deep surface from the *posterior tibial nerve*. With the gastrocnemius it is a plantar-flexor of the foot, coming into action in standing and walking.

Tendo Calcaneus.[1]—This is the most powerful tendon in the body. It narrows as it descends, but near the heel it again expands slightly to be inserted into the middle portion of the posterior surface of the calcaneus. The fleshy fibres of the soleus are continued downwards on its deep surface almost to the heel. A small *bursa* separates the tendon from the upper part of the posterior surface of the calcaneus.

Dissection.—Separate the soleus muscle from the tibia and the fibro-tendinous arch over the vessels. Turn it laterally; sever the arteries which enter it, but preserve its nerves.

The *first fascial septum* is now fully exposed. Note its connexions (see p. 310). Separate it from the flexor and peroneal retinacula; then, divide it longitudinally along the middle line of the leg, and turn the two pieces to the sides.

The middle section of the back of the leg is now opened up, and its contents are exposed—the vessels and the nerve being embedded in some loose areolar tissue. The muscle on the medial side is the *flexor digitorum longus* and the lateral muscle is the *flexor hallucis longus*. In the distal part of the leg, the tendon of the *tibialis posterior* will be seen emerging from under cover of the tendon of the flexor digitorum.

Dissection.—Clean the *posterior tibial nerve* and secure its muscular branches; they arise as a rule in the upper part of the leg. Next, clean the terminal part of the *popliteal artery* and the first part of the *anterior tibial artery* and its branches; then the *posterior tibial vessels* and their branches and tributaries. The *peroneal artery* arises from the posterior tibial about one inch below the commencement of the parent trunk. It soon disappears under cover of the flexor hallucis longus; do not trace it farther at present.

[1] The old name for this tendon—tendo Achillis—and the proverbial expression, "Achilles' heel", recall the Greek legend of the invulnerability of the hero except in the heel by which his mother held him when she dipped him, as an infant, in the river Styx.

Clean the flexors of the toes. Then, separate the two muscles and push the flexor hallucis longus laterally, separating its deep surface from the second fascial septum and from the distal part of the interosseous membrane. As the fibula is approached, the peroneal artery will be found descending between the flexor hallucis longus and the second fascial septum. Trace the artery downwards. Immediately above the inferior tibio-fibular joint, it gives off its *perforating branch*. Now, pull the distal part of the flexor hallucis longus medially and follow the peroneal artery to the lateral side of the calcaneus. In order to expose its terminal branches, divide the peroneal retinacula, and, if necessary, displace the peroneal tendons.

Posterior Tibial Nerve.—This nerve is the continuation of the medial popliteal (tibial) nerve. It begins at the lower border of the popliteus, and descends through the back of the leg, under cover of the first fascial septum, to end about mid-way between the calcaneus and the medial malleolus, under cover of the flexor retinaculum, by dividing into the lateral and medial plantar nerves.

Relations.—From above downwards, it rests on the fascia of the tibialis posterior, the flexor digitorum longus, the lower end of the tibia and the back of the ankle joint. In its upper two-thirds, it is situated deeply, being covered by the superficial muscles of the calf. In its distal part, where it lies about midway between the tendo calcaneus and the medial border of the tibia, it is near the surface, being separated from the superficial fascia merely by the investing layer of the deep fascia and by the first fascial septum ; and at its termination it is under cover of the flexor retinaculum.

The posterior tibial vessels are at first on its lateral side; but they soon cross in front of the nerve, and thereafter lie along its medial side.

Branches.—These are muscular, cutaneous and articular.

The *muscular* branches arise in the upper part of the leg. They supply the tibialis posterior, flexor hallucis longus, flexor digitorum longus and the deeper part of the soleus.

The *cutaneous* branches spring from the lowest part of the nerve. They are the *medial calcanean nerves* (S. 1), which pierce the flexor retinaculum and supply the skin of the posterior and lower surfaces of the heel.

The *articular* branches are small twigs that arise from the lowest part of the nerve and supply the posterior part of the capsule of the ankle joint.

Termination of Popliteal Artery.—The terminal part

of the popliteal artery, which was concealed by the upper border of the soleus, is now fully exposed. It ends at the distal border of the popliteus, where it divides into two branches—the anterior and posterior tibial arteries. At the same point, the *venæ comitantes* of those arteries join together to form the popliteal vein.

Anterior Tibial Artery.—Only a small part of this artery is found in this region, for it passes forwards almost at once through the interosseous membrane to the front of the leg. While in the back of the leg it gives off only one small named branch—the *posterior recurrent*—which runs upwards under cover of the popliteus muscle to the back of the knee joint.

Posterior Tibial Artery.—This is the larger of the two terminal branches of the popliteal trunk, as it carries the main blood-supply to the foot. It takes origin at the distal border of the popliteus muscle, and passes downwards and slightly medially in company with the posterior tibial nerve to the hollow between the medial malleolus and the calcaneus, where it ends, under cover of the flexor retinaculum, by dividing into the lateral and medial plantar arteries.

It is closely accompanied by two *venæ comitantes*, which are connected with each other by small veins that cross in front of the artery and behind it; and it has the same general relations as the nerve.

Branches.—Numerous branches—both large and small—arise from the posterior tibial artery.

The *circumflex fibular artery*, which may arise from the anterior tibial, runs laterally round the neck of the fibula to supply muscles and skin.

A *nutrient artery* springs from the posterior tibial close to its origin and enters the nutrient foramen of the tibia. It is remarkable on account of its large size.

The *muscular branches* supply the deep muscles and the soleus, and *cutaneous branches* are given to the skin on the medial side of the leg.

A *communicating branch* arises about an inch above the calcaneus, and passes laterally, either in front of the flexor hallucis longus or behind it, to join the peroneal artery (Figs. 150, 151, 156).

Medial calcanean branches pierce the flexor retinaculum, and accompany the nerves of the same name.

Peroneal Artery.—This is the largest branch of the posterior tibial. It arises about an inch below the commencement of the parent trunk, and at first runs obliquely downwards and laterally, under cover of the soleus, to reach the fibula, and then descends along the fibula, deep to the

flexor hallucis longus. Immediately above the ankle joint, it emerges from under cover of the flexor hallucis longus, passes behind the inferior tibio-fibular joint and the ankle joint, medial to the peroneal tendons, and breaks up into a number of *lateral calcanean* branches.

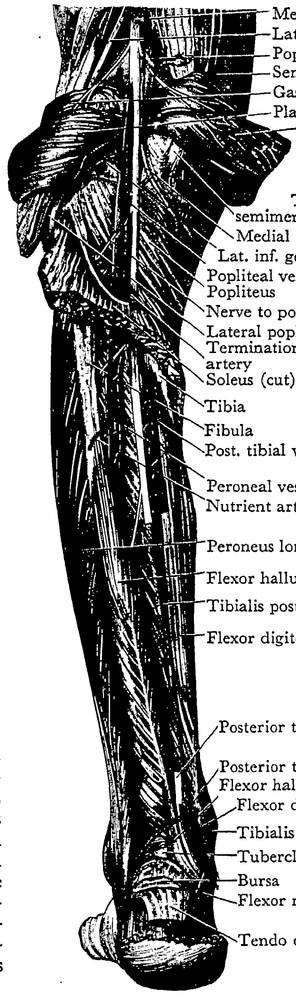


FIG. 156.—Deep Dissection of Back of Leg.

Branches.—In addition to the terminal branches, there are: (1) *muscular* branches; (2) a *nutrient* branch to the fibula; and (3) a *perforating* branch, which pierces the interosseous membrane near the inferior tibio-fibular joint, and descends over the lower part of the fibula into the dorsum of the foot.

The peroneal artery is sometimes as large as the continuation of its parent trunk. Its communication with the posterior tibial artery may then be large, or its perforating branch may partially or entirely replace the dorsalis pedis artery.

DEEP MUSCLES.—The muscles found in the deep dissection of the back of the leg are the popliteus and the three deep muscles of the calf

—the tibialis posterior and the two long flexors of the toes.

The fleshy part of the *popliteus* will be seen lying on the back of the tibia above the soleal line, but its tendon of origin is inside the knee and cannot be seen till the joint is dissected. The *flexor hallucis longus* lies on the back of the fibula, and its tendon will be noticed grooving the posterior surface of the talus as it passes downwards and forwards to gain the sole of the foot. The *flexor digitorum longus* lies on the tibia. The *tibialis posterior* rests on the interosseous membrane; it is between the fleshy bellies of the two flexors but in a deeper plane.

FIG. 157.—Back of Bones of Leg with Attachments of Muscles mapped out.

Popliteus.—The popliteus muscle arises by a stout, round tendon, within the capsule of the knee joint, from the anterior part of the popliteal groove of the femur. The tendon pierces the posterior part of the capsule of the knee joint, and the fleshy fibres which arise from the tendon are directed medially and downwards, and spread out to obtain insertion into the posterior surface of the tibia above the soleal line, and also into the fascia which covers the muscle.

Its nerve has already been seen to arise from the *medial popliteal nerve*. It can now be seen hooking round the distal margin of the muscle to reach the anterior surface.

The popliteus is a flexor of the knee and a medial rotator of the leg at the beginning of the movement of flexion.

The flexors of the toes and the posterior tibial muscle arise from the fascial septa and the interosseous membrane, as well as from the bones of the leg.

Flexor Hallucis Longus.—The long flexor of the big toe arises chiefly from the posterior surface of the fibula, below the origin of the soleus. After passing behind the ankle joint, its tendon occupies a deep groove on the posterior surface of the talus ; it then turns forwards under cover of the flexor retinaculum to gain the sole of the foot, where it runs forwards to be inserted into the terminal phalanx of the big toe.

The flexor hallucis longus is supplied by the *posterior tibial nerve*. It is a flexor of the interphalangeal and metatarso-phalangeal joints of the big toe, and a plantar-flexor of the foot; and it assists in producing inversion of the foot.

Flexor Digitorum Longus.—The long flexor of the toes arises from the posterior surface of the tibia, below the popliteus, and medial to the vertical ridge. After crossing superficial to the distal part of the tibialis posterior, its tendon grooves the lower end of the tibia on the lateral side of the tendon of the tibialis posterior. It is continued under cover of the flexor retinaculum into the sole of the foot, where it divides into four tendons for the lateral four toes, and each tendon is inserted into the terminal phalanx of its toe.

It is supplied by the *posterior tibial nerve*. It is a flexor of the interphalangeal and metatarso-phalangeal joints of the lateral four toes, and it assists in producing plantar flexion and inversion of the foot.

Tibialis Posterior.—The posterior tibial muscle takes origin from the interosseous membrane and the adjoining parts of the posterior surfaces of the tibia and fibula. Its attachment to the interosseous membrane does not reach so high as the attachments to the bones. The upper end of the muscle is therefore bifid ; and the anterior tibial vessels pierce the interosseous membrane between the two parts. In Figs. 141, 146, the compartment which it occupies is shown in a diagrammatic manner, and the surfaces from which it takes origin are indicated. Towards the distal part of the leg, the tibialis posterior inclines medially, under cover of the flexor digitorum longus, and gives place to a strong, flattened tendon which grooves the back of the medial malleolus at the

medial side of the tendon of that muscle, under cover of the flexor retinaculum ; passing from the malleolus, its tendon enters the sole and is inserted chiefly into the tuberosity of the navicular bone and the medial cuneiform bone, and by slips into other bones of the foot. Those slips will be dissected later.

The tibialis posterior is supplied by the *posterior tibial nerve.* It is a plantar-flexor and an invertor of the foot.

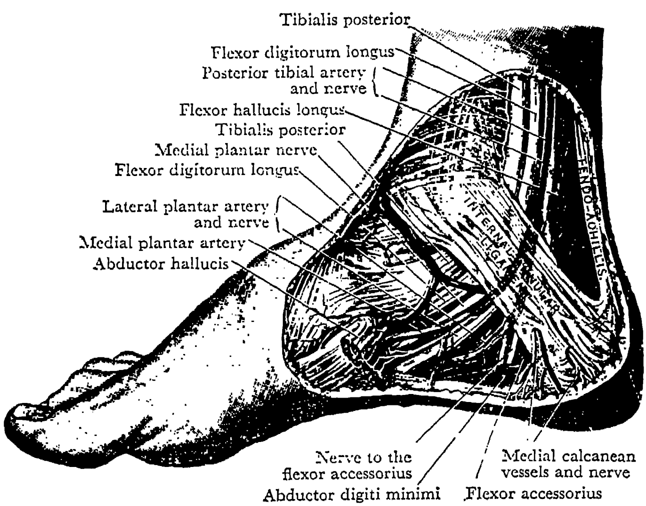


FIG. 158.—Dissection of medial side of Ankle, showing the relations of the Flexor Retinaculum.

Flexor Retinaculum.—The connexions of this thickened band of the deep fascia should now be carefully re-examined. It bridges across the hollow between the medial malleolus and the medial tubercle of the calcaneus, and is attached to both of them. It has already been shown that its proximal border is continuous not only with the investing deep fascia of the back of the leg but also with the septum which covers the deep muscles (see p. 310) ; and it has been pointed out that the septum takes a more important part in the formation of the retinaculum than the investing layer of deep fascia does. Its distal or anterior margin is continuous with the deep fascia of the medial part of the sole, and also gives attachment to

the muscle which is under cover of that portion of fascia—the abductor hallucis.

The structures under cover of the retinaculum lie in the following order from the medial to the lateral side :—

(1) Tendon of tibialis posterior.
(2) Tendon of flexor digitorum longus.
(3) End of posterior tibial artery and commencement of medial and lateral plantar arteries, with their accompanying veins.
(4) Posterior tibial and medial and lateral plantar nerves.
(5) Tendon of flexor hallucis longus.

Synovial Sheaths.—The tendons are isolated from one

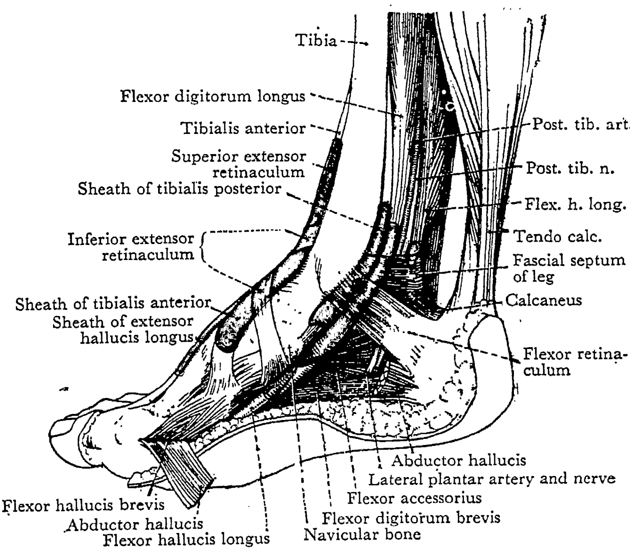


FIG. 159.—Dissection of Leg and Foot showing Synovial Sheaths.

another, and from the vessels and nerve, by septa which pass from the deep surface of the retinaculum to ridges on the adjacent bones. To demonstrate the septa, slit open the retinaculum for a short distance along the line of each tendon. Each of those three compartments will then be seen to be lined with a glistening *synovial sheath* ; and the dissector should investigate the extent of each sheath as far as possible with the aid of a blunt probe. The sheaths end proximally about one inch above the medial malleolus. Distally, the *sheath of*

the tibialis posterior reaches the insertion of the tendon into the navicular bone. The *sheath of the flexor digitorum longus* extends to about the middle of the foot; and the *sheath of the flexor hallucis longus* can be traced, under favourable circumstances, as far as the insertion of the tendon, but sometimes cannot be traced beyond the middle of the first metatarsal bone (Fig. 159).

NERVES AND VESSELS OF THE KNEE.—At different stages of the dissection of the thigh and the leg, articular nerves and vessels that supply the knee joint have been found, and have been partly dissected. Study them now as a whole by following the nerves as far as the capsular ligament of the joint, and cleaning the vessels around the joint, noting their chief anastomoses.

Dissection.—Find the *nerves to the vasti*, and trace their articular filaments down through each muscle to the knee. Clean the *descending branch of the lateral circumflex artery* and the *descending genicular artery* and their branches as far as possible. Find the branch that the posterior division of the obturator nerve sends into the adductor magnus; trace it into the muscle, and follow its longest filament: it emerges from the muscle and becomes the *genicular branch.*

Trace the *superior genicular nerves* and *vessels* to the capsule of the joint; and note the *middle genicular nerve* and *vessels* as they pierce the posterior ligament of the knee. The proximal part of the *inferior lateral genicular nerve* has probably been destroyed. But find the inferior lateral artery and trace it to the lateral ligament of the joint, and the nerve may be found alongside the artery there. Divide the biceps a little above the joint, and pull it downwards to expose the lateral ligament more fully. Clean the ligament from end to end; and trace the nerve and artery forwards between it and the fibrous capsule.

Follow the *inferior medial genicular nerve* and *vessels* along the upper border of the popliteus to the medial ligament. Throw the tendons of the sartorius, gracilis and semitendinosus forwards and pick up the nerve and vessels at the anterior border of the ligament, and trace them onwards.

Now, find the commencement of the anterior tibial artery, and secure its *posterior recurrent branch.* It passes upwards in front of the popliteus. Therefore, cut the popliteus near its lateral end, turn it medially, trace its nerve to its deep surface, and look for the branch which the nerve sends to the superior tibio-fibular joint; then, follow the recurrent artery to its termination. Lastly, turn to the front of the limb. Find the *anterior recurrent branch* of the anterior tibial artery and the *recurrent genicular nerve*; trace them upwards through the tibialis anterior to the knee.

Articular Nerves of Knee Joint.—The knee joint is richly supplied with nerves. No less than ten distinct

branches may be traced to it. The femoral nerve and the lateral and medial popliteal nerves contribute three twigs apiece to it; and the obturator nerve furnishes a filament.

The **femoral nerve** supplies the joint through branches which proceed from the *nerves to the vasti*. These nerves descend through the vasti, and are distributed to its upper and anterior part. The articular branch from the nerve to the vastus medialis is of larger size than the other two, and it accompanies an articular branch of the descending genicular artery.

The **lateral popliteal nerve** gives off:—(1) the superior and inferior lateral genicular nerves, which are accompanied by corresponding arteries; and (2) the recurrent genicular nerve, which is accompanied by the anterior recurrent tibial artery.

The *superior lateral genicular nerve* arises above the popliteal fossa, descends into the fossa, passes under cover of the biceps above the lateral femoral condyle, and pierces the lateral intermuscular septum to reach the upper lateral part of the knee joint.

The *inferior lateral genicular nerve* is small, and may be absent; at any rate, it is often not found. It arises at a variable point, and may arise in common with the superior branch. It runs downwards over the lateral head of the gastrocnemius; then, curving forwards, it passes between the lateral ligament and the capsule of the joint to supply its lower lateral part.

The *recurrent genicular nerve* arises from the end of the lateral popliteal (occasionally from the anterior tibial). Most of its fibres end in the tibialis anterior, but a fine twig or two reach the front of the joint.

The **medial popliteal nerve** furnishes the knee joint with superior and inferior medial genicular branches and a middle genicular nerve, which are accompanied by the corresponding arteries.

The *superior medial genicular nerve* runs medially, above the medial femoral condyle. It passes between the bone and the tendon of the adductor magnus, and reaches the upper medial part of the joint through the vastus medialis.

The *middle genicular nerve* is short. It pierces the posterior ligament to supply the cruciate ligaments (p. 357) and their synovial covering.

The *inferior medial genicular nerve* is the largest of the

articular nerves. It runs downwards and medially along the upper border of the popliteus, and then sweeps forwards below the medial condyle of the tibia, between the bone and the medial ligament of the joint, and finally turns upwards to supply the lower medial part of the capsule.

The *genicular branch* from the **obturator nerve** descends through the substance of the adductor magnus, emerges from the muscle near the opening for the big vessels, and then

FIG. 160.—Anastomosis on Front and Sides of Left Knee Joint.

runs along the postero-medial aspect of the popliteal artery to reach the back of the knee joint.

Anastomosis around Knee Joint.—Eight arteries take part in this anastomosis (Figs. 124, 125, 126, 160). They are the five *genicular branches of the popliteal artery*, the two *recurrent branches of the anterior tibial*, and the *descending genicular branch of the femoral artery*. Like the articular arteries at other joints, they ramify to form rich networks around the knee; and these plexuses give branches to the soft parts that cover the joint as well as to the bones, ligaments and synovial membranes—the largest branches being those that enter the bone to supply the marrow.

The anastomoses are most numerous on the front and sides of the joint; and, in a well-injected specimen, three distinct arches are seen connecting the vessels of the lateral and medial sides—one amidst the superficial fibres of the quadriceps immediately above the patella, another under cover of the ligamentum patellæ immediately below the patella, and the third on the tibia immediately above the insertion of the ligamentum (Fig. 160).

The middle genicular artery takes little share in the network, for it is spent chiefly in the cruciate ligaments and fat in the interior of the joint.

Anastomosis around Ankle Joint.—The dissector should next satisfy himself with regard to the anastomosis of arteries which takes place around the ankle joint. On the *lateral side* of the joint, he will observe inosculations taking place between branches of the following arteries :—(*a*) lateral malleolar ; (*b*) perforating branch of peroneal ; (*c*) terminal part of peroneal ; and (*d*) lateral tarsal.

On the *medial side* of the joint, the medial malleolar branch of the anterior tibial anastomoses with small twigs from the medial calcanean branches of the posterior tibial (Figs. 167, 168).

Sole of the Foot

Before beginning the dissection, revise the surface-anatomy (p. 283), and note that the skin is specially thick over the heel, on the ball of the foot, and, to a less extent, along the lateral border of the foot; on all those parts the weight of the body presses in the erect posture. Other noticeable features are the shortness of the toes as contrasted with the length of the fingers, and the fact that the longest digit of the foot is either the first or the second, and not the middle digit as in the hand.

***Dissection.*—Reflexion of Skin.—Place the limb on the table with the sole of the foot, toes downwards, facing the dissector and the front of the ankle resting on a good-sized block. Two incisions are required—one along the middle line of the sole from the heel to the root of the middle toe ; the other across the sole at the roots of the toes. Reflect the skin to the lateral and medial sides. Make also a longitudinal incision along each toe, and reflect the skin from the toes.**

Superficial Fascia.—When the skin is reflected, the peculiar character of the superficial fascia becomes apparent. Along the lateral border of the foot, at the ball of the foot, and at the heel, it is thick, tough and granular. Traversing it, there are tough, fibrous bands which subdivide the fatty tissue into small lobules, and connect the skin with the deep fascia.

Under the heel, the superficial fascia contains branches of the *medial calcanean vessels* and *nerves*. Farther forwards, the small vessels and nerves that ramify in it are unnamed. On the sides of the toes, it contains the *plantar digital vessels* and *nerves*. Near the webs of the toes and superficial to the digital vessels and nerves, there is a weak band of fibres, called the *superficial transverse metatarsal ligament*, less conspicuous than the corresponding ligament of the palm (Fig. 161).

Dissection.—**Trace the** ***medial*** *calcanean arteries* **and** *nerves* **to their distribution.**

The superficial fascia may now be removed. Divide it along the middle line of the sole, and turn it laterally and medially, cleaning the deep fascia at the same time. As you approach the margins of the foot, note two longitudinal furrows, and secure the small vessels and nerves that pass from the plantar vessels and nerves through the furrows to reach the skin.

Proceed cautiously as you approach the intervals between the heads of the metatarsal bones, for there the ***metatarsal arteries*** **and** ***digital nerves*** **are unprotected by the deep fascia. The nerves and vessels which go to the medial side of the big toe and to the fibular side of the little toe are especially liable to injury, for they perforate the deep fascia farther back than the others. Look for the** *superficial transverse metatarsal ligament* **at the roots of the toes.**

Trace the digital nerves and arteries forwards along the sides of the toes. Then, clean the superficial fascia from the big toe and from one, at least, of the others.

Deep Fascia.—The deep fascia of the plantar surface of the foot and toes is now brought into view. Study the deep fascia of the toes first.

Fibrous Flexor Sheaths.—On each toe, the deep fascia is thickened to form a curved plate, called the fibrous flexor sheath, that holds the flexor tendons against the phalanges. It is strong and dense opposite the phalanges, but is thin and weak opposite the joints in order that it may not hamper their movements. Its margins are attached to the margins of the first and second phalanges (only the first in the big toe), and to the margins of the plantar ligaments of the joints. Anteriorly, it is fixed to the base of the terminal phalanx immediately beyond the insertion of the long flexor tendon. Posteriorly, its end is continuous with the slips of the plantar aponeurosis described on p. 328.

The fibrous flexor sheath, being attached to the margins of the phalanges and plantar ligaments, forms, with them, a tunnel which is occupied by the long and short flexor tendons ; and the tunnel is lined with the synovial sheath that envelops the tendons. Slit open one of the fibrous sheaths to see the tendons and the synovial sheath; and then proceed to study the deep fascia.

The deep fascia of the sole is divisible into three portions—(*a*) a medial, (*b*) an intermediate and (*c*) a lateral. The division is indicated by a difference in the density of the three parts and by two shallow furrows which traverse the foot in a

longitudinal direction. Each of the three portions is in relation to a muscle which takes part of its origin from it.

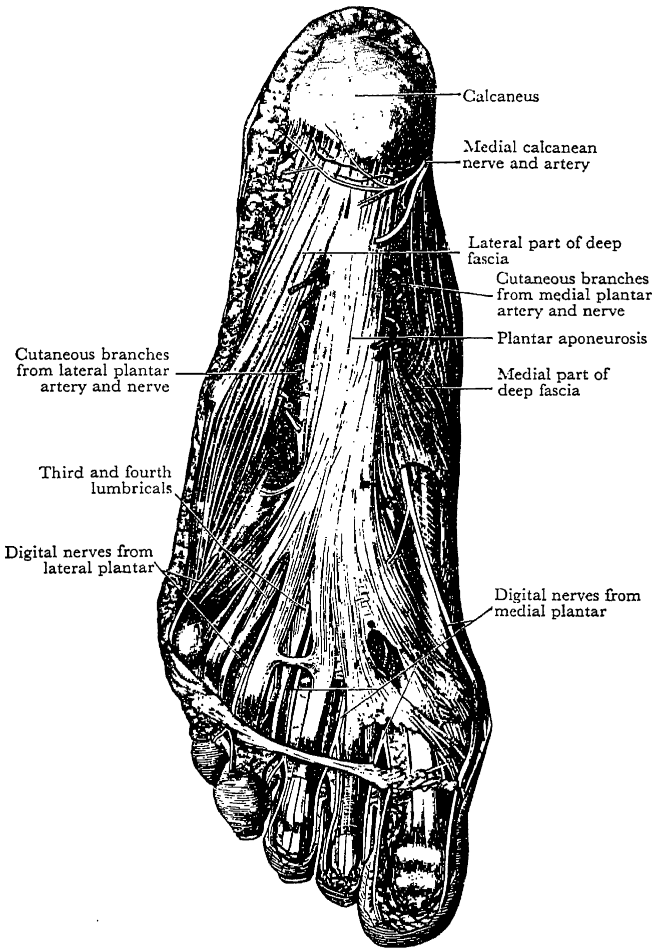


FIG. 161.—Superficial Dissection of Sole of Foot. The skin and superficial fascia, except the superficial transverse ligament, have been removed, and the fibrous flexor sheaths partially opened.

The *medial portion* is the thin fascia that covers the abductor hallucis. The *lateral portion* covers the abductor

digiti minimi. It is stronger than the medial portion, especially laterally, where it is thickened to form a strong band that stretches from the lateral tubercle of the calcaneus to the base of the fifth metatarsal bone (Figs. 161, 162).

Plantar Aponeurosis.—The *intermediate portion* covers the flexor digitorum brevis. It stands out in marked contrast to the lateral and medial portions in point of strength and density, and is called the **plantar aponeurosis.** Its posterior end is narrow, and is attached to the medial tubercle of the calcaneus. It expands as it passes forwards, and, near the heads of the metatarsal bones, it splits into five processes which proceed towards the toes and are bound together by transverse fibres. In the interval between each two of those digital processes, a small artery and nerve and a delicate muscle are seen; they are a plantar metatarsal artery, a plantar digital nerve and a lumbrical muscle.

Trace the processes forwards. One goes to the root of each toe; there, it sends forwards a few superficial fibres to the skin of the creases of the toes, and then divides into two slips. The two slips diverge from each other and pass upwards, embracing the flexor tendons of the toe; their distal edges fuse with the proximal end of the fibrous flexor sheath; their ends are attached to the margins of the plantar ligament of the metatarso-phalangeal joint and to the deep transverse ligaments of the sole—which are flat, fibrous bands that will be dissected later.

In connexion with the plantar aponeurosis two *intermuscular septa* also have to be studied (Figs. 161, 196). They spring from the margins of the plantar aponeurosis along the lines of the longitudinal furrows, and pass upwards into the sole. They consequently lie one on each side of the flexor digitorum brevis, and form partitions which separate it from the abductor hallucis and the abductor digiti minimi. They give partial origin to those muscles, and fuse with the layer of fascia that covers their deep surfaces.

Dissection.—To demonstrate these septa, make a transverse incision through the plantar aponeurosis about an inch in front of its posterior end and a longitudinal cut through the middle of the aponeurosis, in front of that; raise the divided aponeurosis and turn it laterally and medially. As the margins of the flexor digitorum brevis are approached, the septa are brought into view. As the anterior part of the aponeurosis is reflected, avoid injury to the plantar digital arteries and nerves, for they lie close to its deep surface.

Muscles and Tendons of the Sole.—The muscles and tendons of the sole are disposed in four strata separated by fascial partitions in which the plantar vessels and nerves and their branches lie.

Dissection.—Remove the deep fascia from the abductor muscles, taking great care to avoid injury to the digital nerve to the lateral side of the little toe and the digital nerve and artery to the medial side of the big toe. To avoid injuring those structures, seize a reflected portion of the plantar aponeurosis, and cut horizontally through the septum at the side of the flexor digitorum brevis ; then, keep the edge of the scalpel playing closely against the deep surface of the fascia that is being removed.

Before proceeding farther with the dissection, identify the structures exposed by the removal of the deep fascia (Fig. 162).

The *abductor hallucis* lies along the medial border of the sole ; a little lateral to it, a portion of the tendon of the *flexor hallucis longus* is seen ; the *digital artery* and *nerve* to the medial side of the big toe lie between them ; and the muscle seen on a deeper plane is the *flexor hallucis brevis*, which, however, belongs to the third layer of muscles.

The *abductor digiti minimi* lies along the lateral border of the sole. Medial to its anterior half, the *digital nerves* and *vessels* to the little toe are seen, and, on a deeper plane, the *flexor digiti minimi* (which also belongs to the third layer); while, more medially still, a portion of an *interosseous muscle* is visible, though it belongs to the fourth layer.

In the intermediate area, there is the *flexor digitorum brevis* dividing into four tendons for the lateral four toes. *Digital nerves* and *vessels* and *lumbrical muscles* are seen between those four tendons and between the most medial tendon and the flexor hallucis longus.

Dissection.—Cut down into the posterior part of the interval between the abductor hallucis and the flexor digitorum brevis, and secure the posterior parts of the *medial* and *lateral plantar nerves* and *arteries*. Follow the *medial plantar nerve* forwards, and secure the two muscular branches that arise from its trunk. Then, trace its *four digital branches* forwards to the toes, securing —(1) a muscular branch from the most medial one, (2) a muscular branch from the second, and (3) a communicating branch from the fourth to a digital branch of the lateral plantar nerve. At the same time, clean the *medial plantar artery* and its branches.

Next, cut down into the interval between the flexor digitorum brevis and the abductor digiti minimi, just behind the base of the

fifth metatarsal bone, and secure the *lateral plantar artery* and the trunk of the *lateral plantar nerve*, before the nerve divides into its superficial and deep divisions. The artery and the deep division of the nerve bend medially, and pass out of sight. Follow the superficial division of the nerve forwards, and secure :—(1) the branches to the flexor digiti minimi brevis and interossei of the fourth interosseous space ; (2) its two digital branches to the fourth and fifth toes. Clean also the arteries which accompany the nerves.

Now, divide the flexor digitorum brevis across its middle ; throw the anterior part forwards to the toes ; turn the posterior part backwards, and define its attachments ; at the same time, clean the part of the abductor digiti minimi that passes deep to it. Lastly, detach the abductor hallucis from the calcaneus (but not from the flexor retinaculum) and turn it medially.

This dissection exposes the greater part of the *lateral plantar vessels* and *nerve* and the muscles and tendons of the second layer—the tendon of the *flexor digitorum longus*, with its *lumbrical muscles*, and the *flexor digitorum accessorius* inserted into it; and the tendon of the *flexor hallucis longus*, seen at the medial side of the flexor digitorum.

Dissection.—Clean the *lateral plantar nerve* and its muscular branches. The first branch goes to the abductor digiti minimi ; it lies far back, close to the tubercles of the calcaneus. The branch to the flexor accessorius is a little farther forward. Next, clean the *lateral plantar artery* and its branches. Finally, clean the muscles and tendons.

First Layer of Muscles.—These are the short flexor of the toes and the abductors of the big toe and little toe.

Flexor Digitorum Brevis.—This muscle arises from the medial tubercle of the calcaneus and from the fascia and the septa. About the middle of the sole, it divides into four fleshy slips which end in slender tendons for the lateral four toes. Each tendon enters the fibrous flexor sheath of its toe, and is inserted into the middle phalanx ; the insertion will be examined later.

The flexor digitorum brevis is supplied by the *medial plantar nerve*. It is a flexor of the first interphalangeal joints and the metatarso-phalangeal joints of the lateral four toes.

Abductor Hallucis.—The abductor of the big toe takes origin chiefly from the flexor retinaculum, and partly from the medial tubercle of the calcaneus. A strong tendon issues from the fleshy belly, and is joined by fibres of the medial belly of the flexor hallucis brevis ; and it is inserted into the medial side of the base of the proximal phalanx of the big toe.

The abductor hallucis is supplied by the *medial plantar nerve*. It abducts the big toe from the second toe.

Abductor Digiti Minimi.—The abductor of the little toe

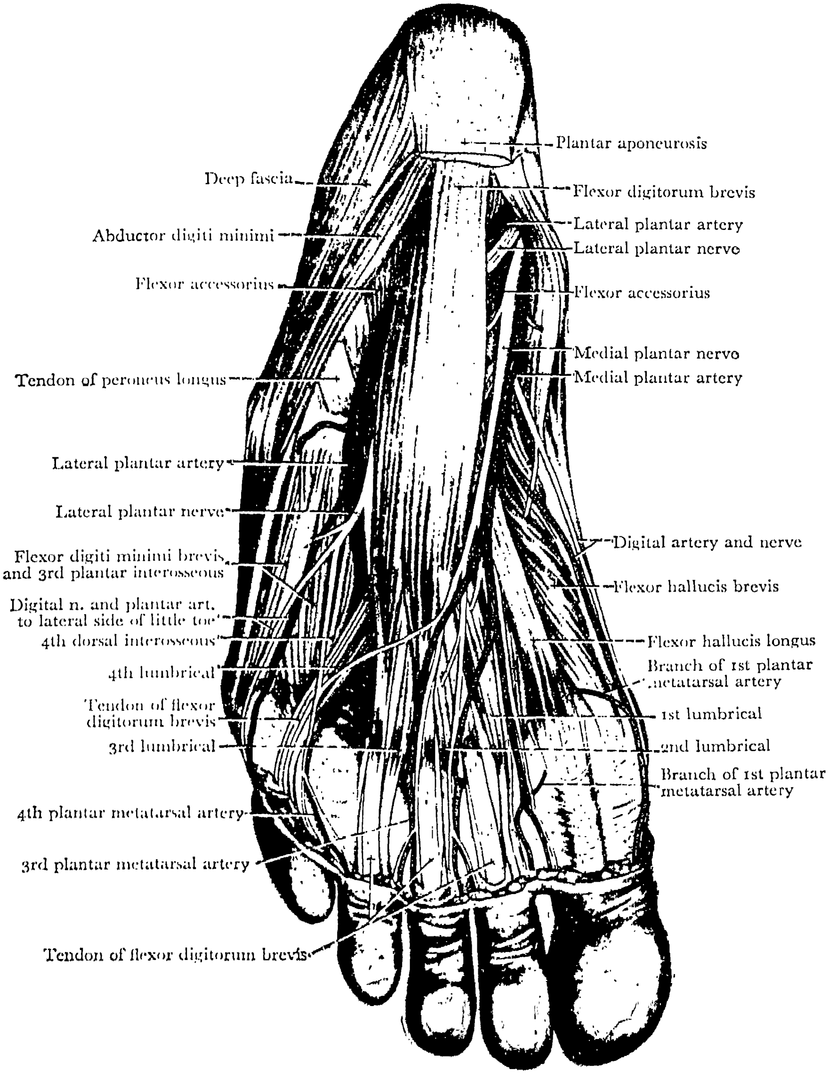
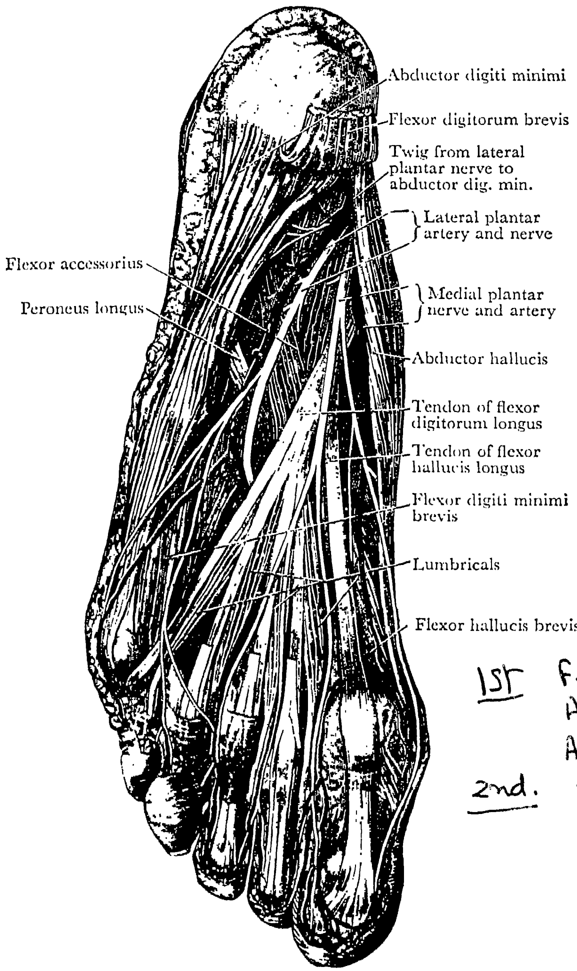


FIG. 162.—Superficial Dissection of Sole of Foot. The plantar aponeurosis has been removed. The abductor digiti minimi and the abductor hallucis have been pulled aside.

The digital distribution of the medial plantar nerve closely resembles that of the median nerve in the hand.



1st F.D.B. M
A.H M
A.D.M. L.
2nd. F.D.L.
F.H.L.
F.A. L.
LUMB-1 M
OTHERS L.

FIG. 163.—Dissection of Sole of Foot. The flexor digitorum brevis has been reflected.

3rd. F.H.B -M
F.D.M.-L
ADD.H. L.

The *muscular branches* go to four muscles of the sole:—

1 Abductor hallucis.
1 Flexor digitorum brevis.
3 Flexor hallucis brevis.
4 First lumbrical.

The branches for the *abductor hallucis* and *flexor digitorum brevis* arise from the trunk of the nerve a short distance from its origin. The nerve to the *flexor hallucis brevis* arises from the first digital nerve; and the nerve to the *first lumbrical muscle* from the second digital nerve.

Lateral Plantar Nerve (S. 1, 2).—The lateral plantar nerve is the smaller terminal branch of the posterior tibial nerve, and corresponds to the ulnar nerve in the palm of the hand. It begins, under cover of the flexor retinaculum, about midway between the medial malleolus and the calcaneus. With the lateral plantar vessels, it runs laterally and forwards, between the first and second layers of muscles, towards the base of the fifth metatarsal bone, and it ends near that base by dividing into a *superficial* branch and a *deep* branch (Fig. 163). It is under cover of the following structures in succession—flexor retinaculum, abductor hallucis, flexor digitorum brevis. At its termination, it may still be deep to the flexor brevis, or may lie under cover of the deep fascia in the interval between that muscle and the abductor digiti minimi.

Branches.—Besides the two terminal branches, the trunk of the nerve gives off muscular and cutaneous branches.

The *muscular* branches supply the *abductor digiti minimi* and the *flexor digitorum accessorius*. The *cutaneous* branches appear through the interval between the flexor digitorum brevis and the abductor digiti minimi, and supply the skin of the lateral part of the sole.

The **superficial branch** divides at a varying point (Figs. 162, 163) into two digital branches.

The *lateral digital branch* runs forwards along the lateral side of the little toe. The *medial digital branch* crosses the flexor tendons of the little toe and divides into two branches which run along the contiguous sides of the fifth and fourth toes. It receives a communicating branch from the fourth digital branch of the medial plantar nerve. These digital branches supply the skin of the plantar surface of the little toe and of the lateral half of the fourth toe, and send small branches to supply the skin on the dorsum of the distal phalanx; they give twigs also to the joints and ligaments of these toes.

Muscular twigs arise either from the stem of the superficial branch or from the lateral digital branch. They supply the flexor digiti minimi brevis and the third plantar interosseous and fourth dorsal interosseous muscles.

The **deep branch** is really the continuation of the lateral plantar nerve. It curves medially and forwards, between the third and fourth layers of muscles, towards the first metatarsal bone, and it will be dissected later. Its branches are *muscular* and *articular*; they supply the adductor of the big toe, the lateral three lumbricals, most of the interossei, and the intertarsal and tarso-metatarsal joints.

Medial Plantar Vessels.—The medial plantar artery arises, as a terminal branch of the posterior tibial, under cover of the flexor retinaculum. It varies in size but usually is small. It is accompanied by venæ comitantes and the medial plantar nerve; and it ends by joining the digital branch which the first metatarsal artery sends to the medial side of the big toe (Figs. 166, 167).

It gives *muscular* branches to adjacent muscles; *cutaneous* branches to the medial part of the foot; and, according to its size, it may give off one or more *digital* branches to accompany the digital branches of the medial plantar nerve (Fig. 166).

Lateral Plantar Vessels.—The lateral plantar artery is the larger of the two terminal branches of the posterior tibial artery. It arises under cover of the flexor retinaculum, and, accompanied by venæ comitantes and the lateral plantar nerve, it runs across the sole to the fifth metatarsal bone near its base. It then runs medially with the deep branch of the nerve—crossing the sole for the second time. This second portion is called the **plantar arch**. It lies deep in the sole, and terminates at the proximal extremity of the first intermetatarsal space by joining the end of the dorsalis pedis artery (Figs. 167, 168). The arch will be dissected later.

The branches of the part of the artery now exposed are:—(1) *Muscular* branches to adjacent muscles. (2) *Cutaneous* branches to the lateral and posterior parts of the sole.

> ***Dissection.***—**Detach the abductor digiti minimi from its origin, and turn it forwards, in order that a good display may be obtained of the second stratum of the sole.**

SECOND LAYER OF MUSCLES AND TENDONS.—This layer is made up of the tendons of the two long flexors of the toes and the muscles associated with the tendon of the flexor digitorum, namely, the flexor accessorius and the four lumbrical muscles.

As the tendon of the *flexor hallucis longus* enters the sole it grooves the plantar surface of the sustentaculum tali and

inclines medially, deep to the tendon of the flexor digitorum longus, towards the big toe. The tendon of the *flexor digitorum longus*, on the other hand, inclines laterally, superficial to the tendon of the flexor hallucis longus, to reach the middle of the foot, where it divides into four tendons for the lateral four toes; it receives the insertion of the *flexor digitorum accessorius*, and its four tendons give origin to the *lumbrical muscles*. Where the long tendons cross each other, the tendon of the flexor hallucis longus gives a slip to the deep surface of the tendon of the flexor digitorum longus.

Sir William Turner[1] called attention to the fact that this slip varies greatly in thickness and distribution. Its fibres may all go into the tendon for the second toe; they usually go into the tendons for the second and third toes, or second, third and fourth; very rarely do they go into all four tendons.

Dissection.—Turn over the tendons of the flexor digitorum and trace the fibres of the slip of the flexor hallucis into them. Then, follow the tendons of the long and short flexors to the toes, and open one of the fibrous flexor sheaths.

Flexor Digitorum Accessorius.—This muscle acts as a direct flexor of the toes, and serves also to bring the tendons of the long flexor muscle into line with the toes upon which they operate. It arises by two heads which embrace the calcaneus and the long plantar ligament. The *medial head*, wide and fleshy, springs from the medial surface of the calcaneus; the *lateral head*, narrow, pointed and tendinous, takes origin from the lateral margin of the plantar surface of the calcaneus. The muscle is inserted into the tendon of the flexor digitorum longus in the middle of the sole. It is supplied by the *lateral plantar nerve*.

Lumbrical Muscles.—The lumbrical muscles of the foot are more slender than those of the hand. They are four in number, and arise from the tendons of the flexor digitorum longus in the manner shown in Fig. 164. Their tendons cross the medial sides of the metatarso-phalangeal joints of the lateral four toes, and each is inserted into the base of the proximal phalanx and slightly into the extensor expansion (see p. 293). The *first lumbrical* is supplied by the *medial plantar nerve*; the *others* are supplied by the *lateral plantar nerve*.

[1] Professor of Anatomy, University of Edinburgh, 1867–1903; Principal, 1903–1916.

Flexor Tendons in the Toes.—In the digits, the tendons lie in the osteo-fibrous canals formed by the fibrous flexor sheaths and the phalanges and plantar ligaments of the joints, and they are enclosed in synovial sheaths.

The **tendon of the flexor hallucis longus**, after giving its slip to the tendon of the flexor digitorum longus, runs forwards to the big toe, and is inserted into the base of the terminal phalanx.

Two tendons enter the canal in each of the four smaller toes—a tendon of the **flexor digitorum longus** and a tendon of the **flexor digitorum brevis.** Opposite the posterior part of the first phalanx, the short flexor is superficial; but, at the middle of the phalanx, the tendon of the short flexor is perforated by the tendon of the long flexor, which passes forwards to be inserted into the base of the terminal phalanx, whilst the tendon of the short flexor, beyond the perforation, splits into two parts which are attached to the margins of the second phalanx.

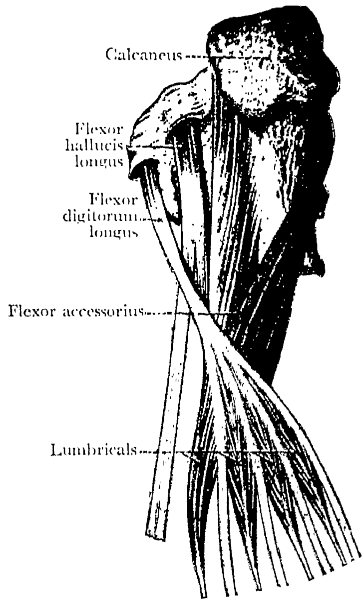


FIG. 164.—Second Layer of Muscles and Tendons in Sole of Foot.

Synovial Sheaths of the Digits.—Each osteo-fibrous canal is lined with a synovial sheath. The sheath begins in the sole near the middle of the metatarsal bone, and extends to the insertion of the long flexor tendon, *i.e.*, to the *base* of the terminal phalanx. The sheath of the little toe is usually continuous with the sheath that envelops the main tendon of the flexor digitorum longus.

The sheath has two layers. One layer lines the canal; the other layer clothes the tendons, enveloping them separately; and the two layers are continuous with each other at the ends of the sheath. The sheath facilitates the play of the

tendons when the muscles are in action, for the opposed surfaces of the layers are smooth and glistening, and are coated with a film of synovia.

The sheath forms folds called *vincula* which pass between the tendons and the bones, and carry small arteries to the tendons.

There are two sets of vincula—short and long. Two *vincula brevia* are present in each sheath. They are short triangular folds at the insertions of the tendons, exactly similar to those found in the fingers (Fig. 67, p. 145). The *vincula longa* are slender bands, irregular in number and position, that pass between the two tendons, and between the tendons and the first phalanx.

Dissection.—To bring the third layer of muscles into view :—Divide the two heads of the flexor accessorius, and draw the muscle forwards from the lateral plantar vessels and nerve. Sever also the tendons of the flexor digitorum longus and the flexor hallucis longus at the point where they emerge from under cover of the flexor retinaculum, and turn them towards the toes, after cutting the branch from the lateral plantar nerve to the flexor accessorius. As the tendons of the long flexor of the toes are turned forwards, the lumbrical muscles will be raised, and the nerves to the *second, third* and *fourth* must be looked for. Lastly, cut the medial plantar nerve close to its origin and turn it aside.

The deep division of the lateral plantar nerve and the plantar arterial arch are partially exposed, but they will be more fully displayed at a later stage.

THIRD LAYER OF MUSCLES.—The muscles of this layer are the adductor and short flexor of the big toe and the short flexor of the little toe (Fig. 165).

The *flexor hallucis brevis* lies on the first metatarsal bone, along the lateral side of the abductor hallucis.

The *oblique head of the adductor hallucis* has a very oblique position in the sole, and hides the interosseous muscles to a great extent. It lies lateral to the flexor hallucis brevis. The *transverse head* lies across the plantar ligaments of the metatarso-phalangeal joints.

The *flexor digiti minimi brevis* lies on the fifth metatarsal bone.

Dissection.—Clean all those muscles from end to end, but avoid injury to the branches of the deep division of the lateral plantar nerve—especially its branches to the lumbrical muscles. Clean also the exposed part of the plantar arch.

Flexor Hallucis Brevis.—The short flexor of the big toe arises from the cuboid bone and from adjoining slips of the tendon of the tibialis posterior. It is narrow and tendinous at its origin, but it soon widens to form two partly separated fleshy bellies which ultimately divide to be inserted by tendons—one on each side of the base of the proximal phalanx of the big toe, fusing with the plantar ligament of the metatarso-phalangeal joint. The medial tendon is inserted in common with the abductor hallucis, and the lateral tendon with the adductor; in each tendon of insertion a sesamoid bone is developed (Fig. 191).

The flexor hallucis brevis is supplied by the *medial plantar nerve*. It flexes the first metatarso-phalangeal joint.

Adductor Hallucis.—The adductor of the big toe has two separate heads—oblique and transverse (Fig. 165).

The *oblique head* arises from the fibrous sheath of the peroneus longus tendon and from the bases of the second, third and fourth metatarsal bones. The *transverse head* springs from the plantar ligaments of the lateral four metatarso-phalangeal joints. The two heads converge as they approach the root of the hallux, and blend to be inserted, with the lateral tendon of the short flexor, into the lateral side of the base of the proximal phalanx.

Both heads of the adductor hallucis are supplied by the *deep division* of the *lateral plantar nerve*. The oblique head adducts and flexes the big toe; the transverse head draws the roots of the toes closer together and accentuates the curvature of the transverse arch made by the metatarsal bones.

Flexor Digiti Minimi Brevis.—The short flexor of the little toe is a single fleshy slip which springs from the base of the fifth metatarsal bone and the fibrous sheath of the peroneus longus tendon. It is inserted into the lateral side of the base of the proximal phalanx of the little toe. Its nerve comes from the *superficial division* of the *lateral plantar nerve*. It flexes the little toe at the metatarso-phalangeal joint.

Dissection.—Divide the common tendon of insertion of the abductor and flexor hallucis brevis; turn the two muscles aside, and find the *sesamoid bones* in the tendons of the flexor brevis.

Sesamoid Bones in the Foot.—Two small sesamoid bones—each about the length and breadth of the nail of a

little finger—are found in the tendons of the *flexor hallucis brevis* as they fuse with the plantar ligament of the metatarso-

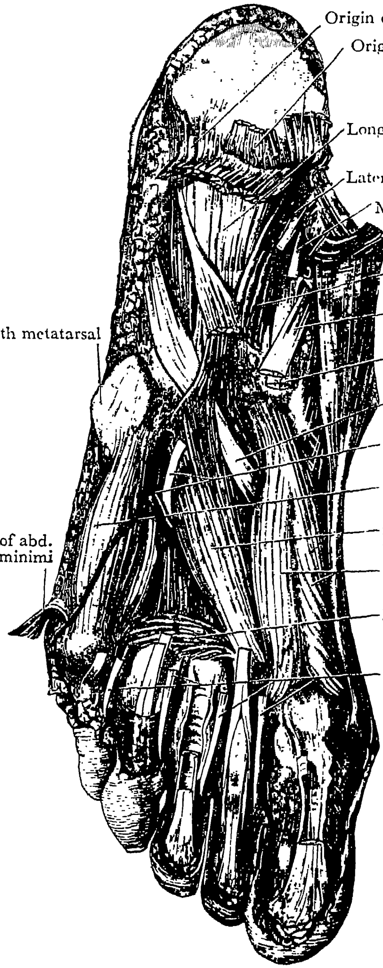


FIG. 165.—Deep Dissection of Sole of Foot.

phalangeal joint; indeed, these bones replace that ligament almost entirely, and their upper surfaces are smooth for

articulation with the lower surface of the head of the metatarsal bone, which is grooved for their reception. The medial part of the ball of the foot owes its size and firmness largely to them.

Radiographs sometimes disclose minute nodules of bone in one or more of the other metatarso-phalangeal joints; and it will be seen later that a sesamoid bone or a sesamoid cartilage is developed in the tendons of both the *peroneus longus* and the *tibialis posterior* as they enter the sole.

Dissection.—Detach the flexor hallucis brevis and the oblique head of the adductor from their origins and throw them towards their insertion, in order to display the entire length of the plantar arterial arch, the deep division of the lateral plantar nerve, and the termination of the dorsalis pedis artery. As you raise the oblique head of the adductor, secure its nerve and retain it. Then, clean the *deep division of the plantar nerve,* and trace its branches; the branch to the second lumbrical needs especial care. Lastly, clean the *plantar arch* and its branches.

Deep Division of Lateral Plantar Nerve.—This branch arises from the parent trunk near the base of the fifth metatarsal bone. It curves medially and forwards towards the medial side of the foot, and it ends in the deep or upper surface of the oblique head of the adductor hallucis.

It is deeply placed in the sole, immediately behind the plantar arterial arch. It rests against the interosseous muscles and the posterior parts of the metatarsal bones, under cover of the flexor tendons, the lumbrical muscles and the oblique head of the adductor hallucis.

Branches.—These are *muscular* and *articular.*

The *muscular branches* supply the two heads of the *adductor hallucis*, the lateral *three lumbrical* muscles, the medial *three dorsal interossei* and the medial *two plantar interossei.*

The branches to the transverse head and to the lumbricals emerge from under cover of the oblique head and run forwards and downwards to these muscles; but the branch to the second lumbrical passes across the upper surface of the transverse head before it turns downwards to its muscle.

The *articular branches* are fine filaments that arise from the stem of the nerve and from its muscular branches; they supply the intertarsal and tarso-metatarsal joints.

Plantar Arch.—The plantar arterial arch is the continuation of the lateral plantar artery across the sole of the foot.

It runs from the level of the base of the fifth metatarsal bone to the base of the first interosseous space, where it is joined by the terminal portion of the dorsalis pedis artery. Its course is curved, with the concavity backwards (Figs. 166, 168). It is accompanied by two venæ comitantes, and lies immediately

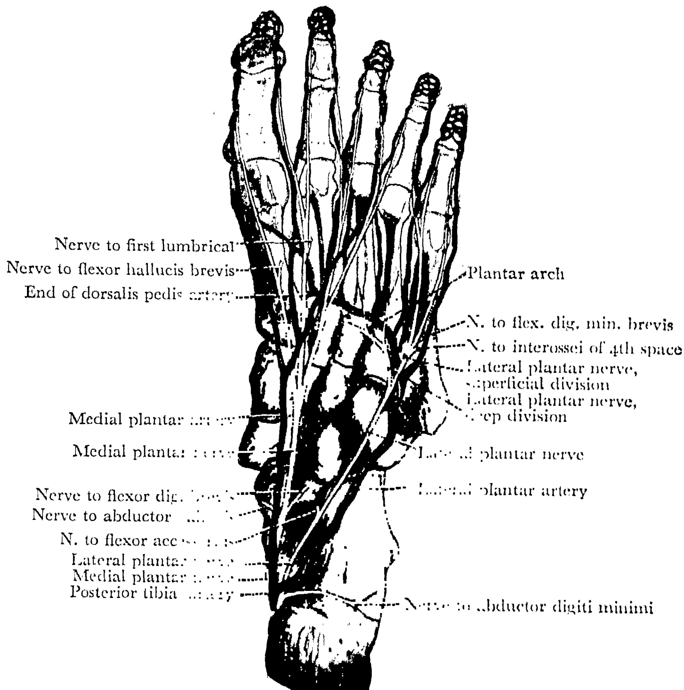


FIG. 166.—Arteries and Nerves of Sole of Foot.
The plantar nerves and their branches are uncoloured.

in front of the deep branch of the lateral plantar nerve ; its relations are therefore the same as those of the nerve.

Branches.—*Articular branches* arise from the concavity of the arch, and run backwards to supply the intertarsal and tarso-metatarsal joints.

Three *posterior perforating branches* pass upwards through the lateral three intermetatarsal spaces and join the corresponding dorsal metatarsal arteries.

Three *plantar metatarsal arteries* run forwards opposite the lateral

PLATE XXXIII

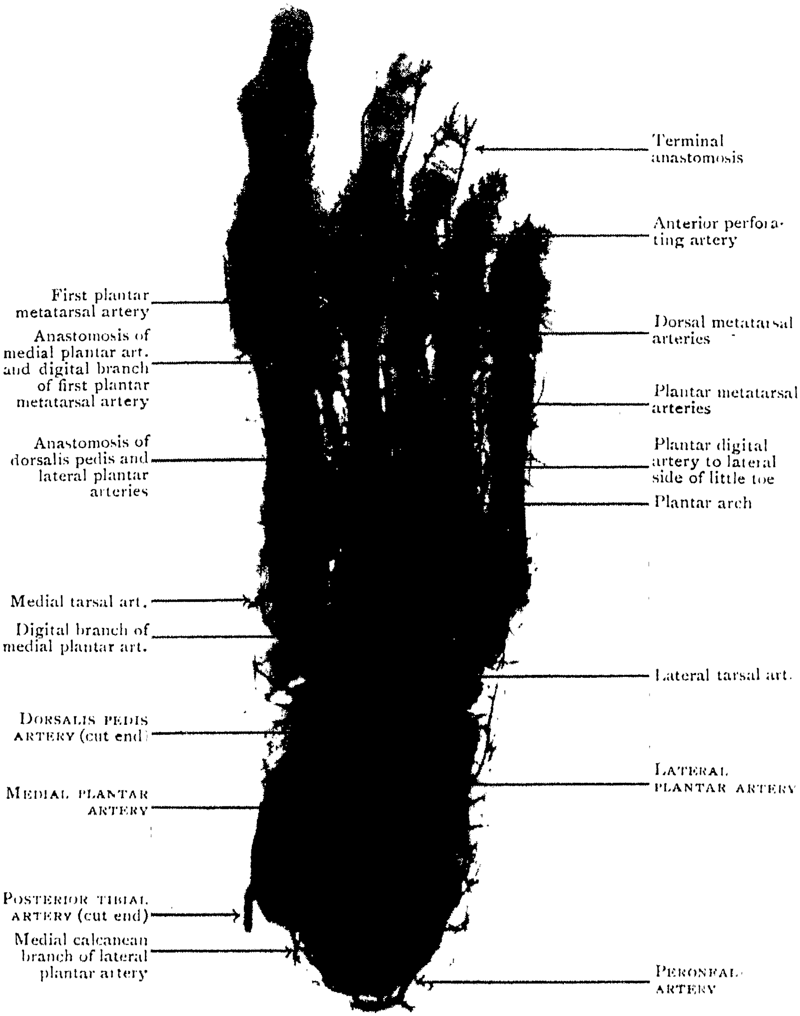


FIG. 167.—Radiograph of Foot, separated at ankle after injection of the Arteries with radio-opaque material (from positive print). Cf. Figs. 166, 168.

[*Facing p.* 342

PLATE XXXIV

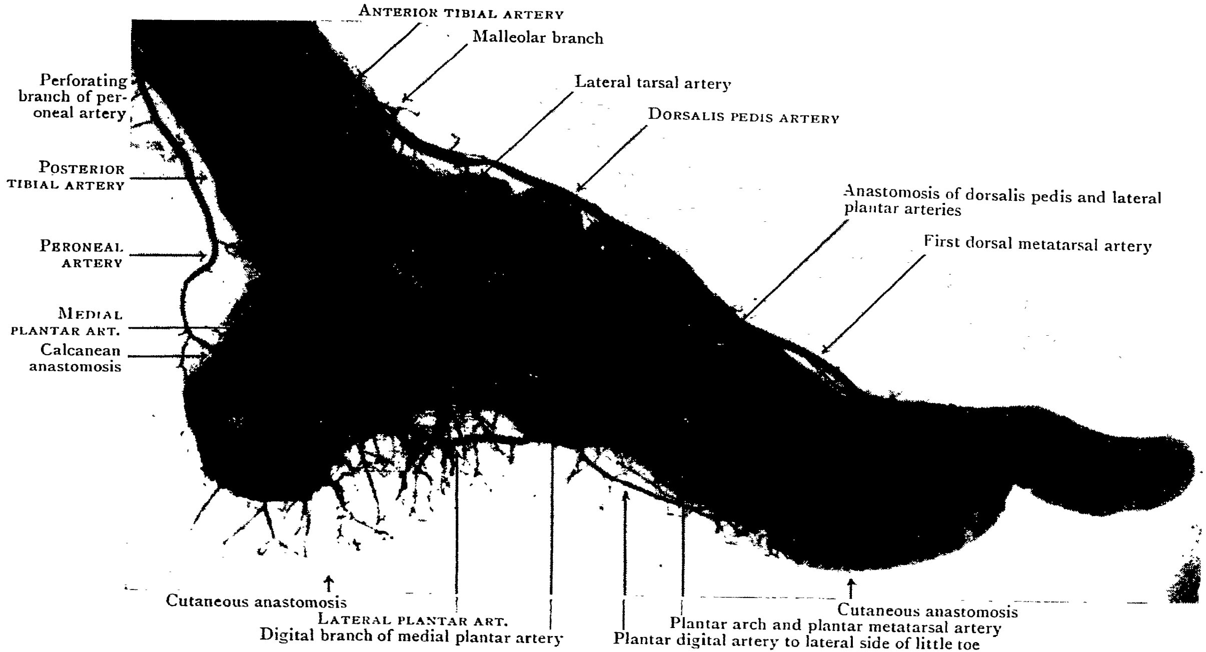


FIG. 168.—Lateral Radiograph of Foot after injection of the Arteries with radio-opaque material (from positive print) Cf. Figs. 166, 167.

[Facing p. 343

three spaces. Each gives off an *anterior perforating artery* and bifurcates into *plantar digital arteries* that supply the contiguous sides of the lateral four toes. The *lateral plantar digital artery of the little toe* springs independently from the lateral extremity of the arch.

As in the hand, the digital arteries unite, opposite the terminal phalanx, to form an arch from which fine branches are sent to the pad of the toe and the bed of the nail.

First Plantar Metatarsal Artery.—This artery arises from the plantar end of the dorsalis pedis, at the point where the dorsalis pedis joins the plantar arch. It runs forwards to the cleft between the big toe and the second toe, where it divides into two *plantar digital arteries* for the supply of the adjacent sides of the first and second toes. Before it divides, it gives off the plantar digital artery to the medial side of the big toe, which is joined by the terminal part of the medial plantar artery.

> ***Dissection.***—Detach the transverse head of the adductor hallucis from its origin and turn it towards the hallux, to display the deep transverse ligaments of the sole.

Deep Transverse Metatarsal Ligaments.—This name is given to four strong, flat bands that lie between the heads of the metatarsal bones. They are attached to the margins of the plantar ligaments of the metatarso-phalangeal joints; the plantar ligaments are firmly attached to the bases of the proximal phalanges; and, therefore, the transverse ligaments prevent the roots of the toes from spreading apart. The lumbrical muscles and the plantar digital vessels and nerves pass forwards across the plantar surfaces of the transverse ligaments; and the interosseous muscles cross their dorsal surfaces.

FOURTH LAYER OF MUSCLES AND TENDONS.—The muscles are the interossei, and the tendons are those of the peroneus longus and tibialis posterior.

Owing to the arched arrangement of the skeleton of the foot, the more medial *interosseous muscles* are very deeply placed, but the more lateral members are near the surface, and may have been seen early in the dissection of the sole. The *tendon of the peroneus longus* crosses the sole obliquely from the lateral to the medial side; the slips of the *tendon of the tibialis posterior* pass laterally and forwards from the medial side. These tendons, crossing the sole obliquely from opposite directions, brace up the foot, and are the chief agents in maintaining both the longitudinal and the transverse arches.

> ***Dissection.***—Clean the *interosseous muscles*. To follow their tendons, divide the deep transverse ligaments, and pull the toes apart. Detach the flexor digiti minimi brevis from its origin

and turn it towards its insertion, in order to expose the most lateral interossei more fully. The dorsal interossei should be cleaned on both plantar and dorsal aspects of the foot.

Interossei.—There are seven interosseous muscles—three plantar and four dorsal. They lie between the metatarsal bones and arise from them ; and they adduct and abduct the lateral four toes to and from the middle line of the *second* toe. Note the difference from the arrangement of the interosseous muscles of the hand, whose actions are referred to the *middle* digit.

The general principle of origin, insertion and action is the same as in the hand (p. 168)—the *plantar interossei* arise

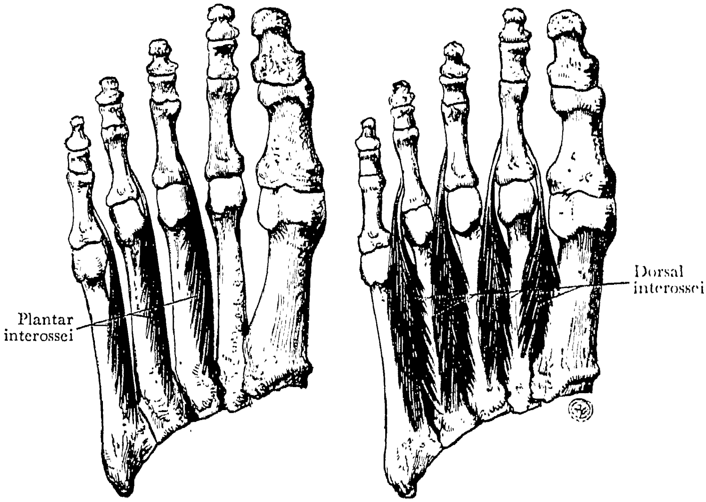


FIG. 169.—Interosseous Muscles of Right Foot. Cf. Figs. 83, 84, pp. 168, 169.

each from the metatarsal bone of the toe upon which it acts, the *dorsal interossei* from the sides of the metatarsals between which they lie ; the insertions are mainly into the bases of the proximal phalanges and also, though less effectively, into the extensor expansions (p. 293).

The *plantar muscles* adduct the lateral three toes towards the second toe ; the *dorsal muscles* abduct the second, third and fourth toes from the middle line of the second toe. The sides of the toes on which they are inserted correspond to

these actions; and they all, in addition, flex the metatarso-phalangeal joints and help, feebly, to extend the inter-phalangeal joints.

Dissection.—Put tension upon the tendon of the *tibialis posterior*. Clean its principal insertion and the various slips which it sends forwards and laterally. Then, pull upon the tendon of the *peroneus longus*; cut through the fibrous bridge that holds it in place in the groove of the cuboid bone, and follow the tendon to its insertion.

Tendon of Tibialis Posterior.—After this tendon enters the sole, it divides into two parts. The medial is the larger and is inserted into the tuberosity of the navicular bone and the adjoining part of the lower surface of the medial cuneiform bone. The lateral part lies in a groove on the plantar surface of the navicular bone and divides into slips which spread out from it to every bone of the tarsus except the talus, and also to the bases of the second, third and fourth metatarsal bones.

As the tendon of the tibialis posterior enters the sole and approaches its chief insertion, it lies on the plantar surface of a strong, flat band called the *plantar calcaneo-navicular ligament* or "spring ligament". The tendon is separated from the ligament by the distal part of its synovial sheath, and the surface of the ligament is therefore smooth and glistening. The ligament stretches from the sustentaculum tali of the calcaneus to the navicular bone, and supports the head of the talus. The

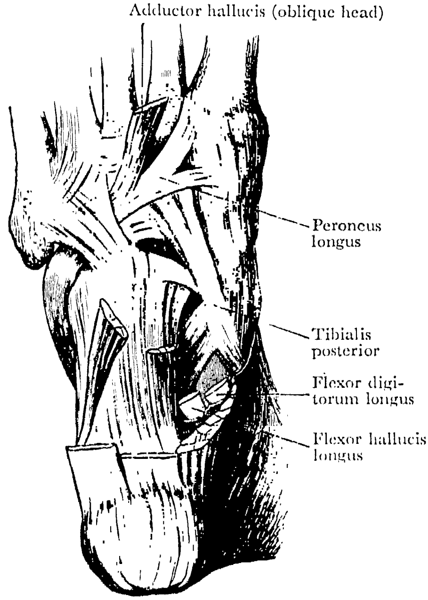


FIG. 170.—Insertions of Tibialis Posterior and Peroneus Longus in the Right Foot.

tendon also, through the ligament, supports the talus; and, at this point, it has developed within it a sesamoid nodule of fibro-cartilage which may be ossified to become a sesamoid bone.

Tendon of Peroneus Longus.—This tendon turns round the lateral margin of the foot, and runs medially, across the sole, in the groove on the plantar surface of the cuboid bone, to reach its insertion into the base of the first metatarsal bone and adjoining part of the medial cuneiform bone. As it traverses the sole, it is covered by a *fibrous sheath*, derived mainly from the long plantar ligament. Attached to the margins of the groove on the cuboid, the sheath converts the groove into a tunnel which is lined with the *synovial sheath* that envelops the tendon; it thus facilitates the movement of the tendon and prevents its displacement.

Just before the tendon enters the tunnel, it is thickened and contains a nodule of fibro-cartilage or a sesamoid bone (Fig. 191) which plays upon a facet situated on the posterior margin of the lateral end of the groove on the cuboid.

Dissection.—**Bring the dissection of the sole of the foot to an end by disarticulating the proximal end of the first metatarsal bone. A good view is thus obtained of the continuity between the dorsalis pedis artery and the plantar arch.**

JOINTS OF LOWER LIMB

The **hip joint** was dissected before the limb was removed from the body.

The dissection of the knee joint, the ankle joint, the tibio-fibular joints, and the various joints of the foot may now be proceeded with. If the ligaments have become at all dry, soak the limb in water over-night.

Knee Joint

Three bones—the distal end of the femur, the patella and the proximal end of the tibia—take part in the formation of the **knee joint**, which is the largest and most complicated joint in the body.

In all positions of the joint, the patella is in contact with the femur and the femur with the tibia. The bones do not

PLATE XXXV

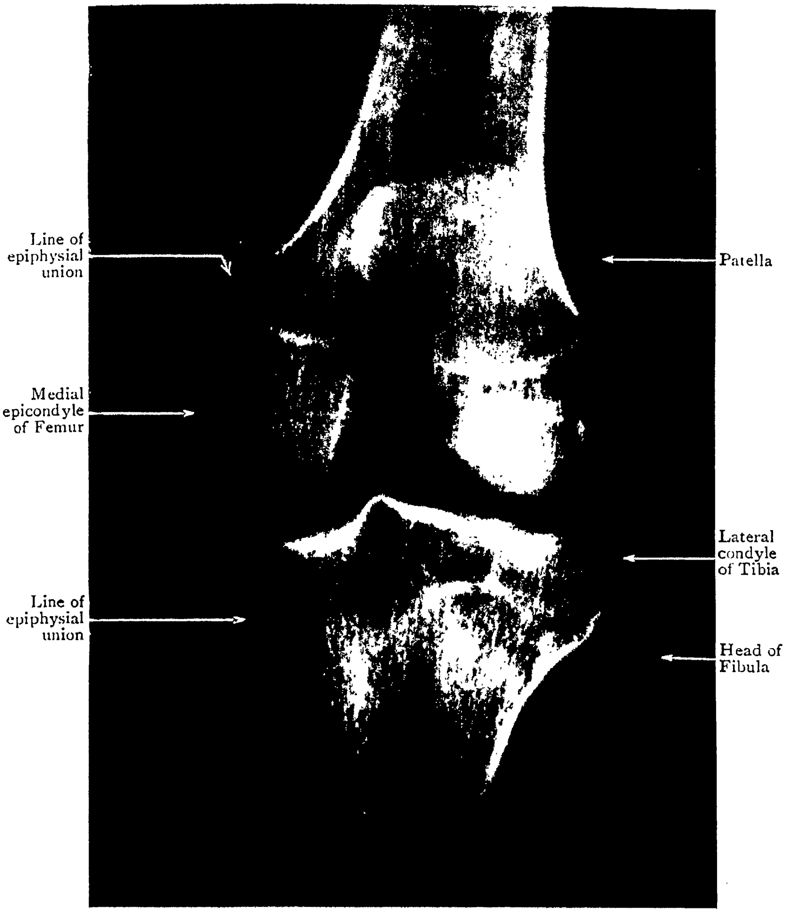


FIG. 171.—Radiograph of Left Knee of young man aged 22. The union of the epiphysis of the Femur is not quite complete.

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PLATE XXXVI

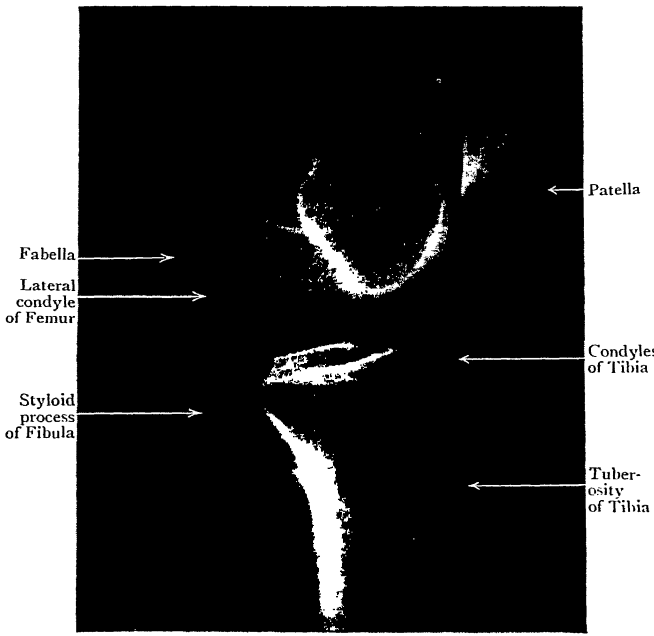

FIG. 172A.—Lateral Radiograph of same Knee as in Fig. 171, in extension. Note the areas of contact of the Femur with the Patella and Tibia; also the sesamoid bone (Fabella) in the lateral head of the gastrocnemius muscle.

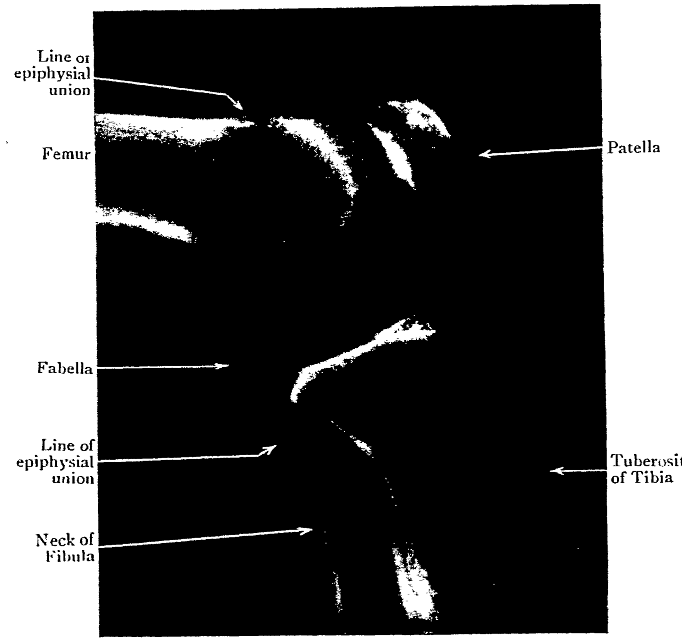

FIG. 172B.—Lateral Radiograph of the same Knee, semi-flexed. Note the change in the areas of contact of the Femur with the Patella and Tibia.

[Facing p. 347

interlock with one another; but the areas of contact are large and the ligaments and surrounding muscles are strong; dislocation of the joint is therefore rare, in spite of the many strains to which it is subjected.

The femoral condyles are partly separated from the tibial

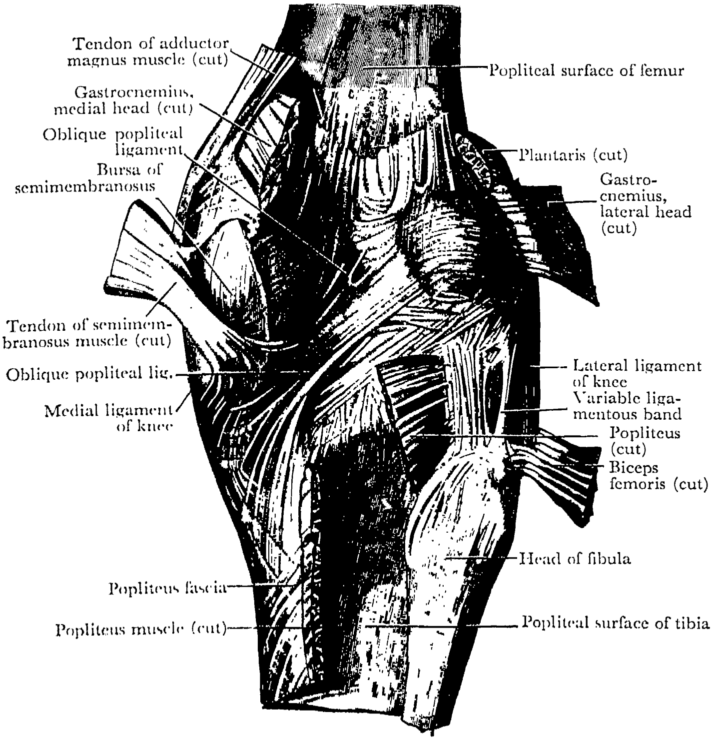

FIG. 173.—Right Knee Joint. Posterior view.

condyles by two sharply curved pieces of fibro-cartilage called the *semilunar cartilages* or *menisci*; they lie on the marginal parts of the tibial condyles (Fig. 176), and, being wedge-shaped in section, they slightly deepen the surfaces for articulation with the femoral condyles. In the interior of the joint, there are also two very strong bands which pass from the top of the tibia to the two femoral condyles; they cross each other, and are called therefore the *cruciate ligaments*

of the knee; and they take the chief part in holding the femur and tibia together.

The three bones of the joint are united also by (1) an imperfect *fibrous capsule*, which envelops the joint incompletely, and by (2) supplementary bands which have been partly examined already—namely, the *lateral* and *medial ligaments* of the knee, the *oblique popliteal ligament*, and the *ligamentum patellæ*, which serves as an anterior ligament.

Dissection.—**Remove the popliteal vessels and nerves and the muscles that surround the knee joint. Leave portions of the tendons of the biceps femoris, semimembranosus, sartorius, semitendinosus, gracilis and popliteus, and also small pieces of the heads of the gastrocnemius, in order that their connexions with the ligaments of the joint may be studied. Define the margins of the ligamentum patellæ.**

Articular Capsule.—The fibrous capsule is thin, wide and membranous at the back, thicker and shorter at the sides, and absent in front, where it is replaced not only by the patella but also by the ligamentum patellæ below the patella, and by the tendon of the quadriceps above the patella.

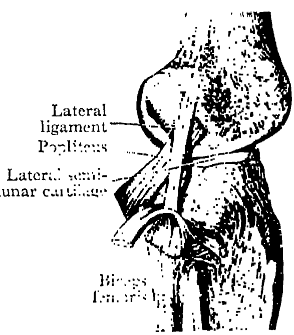

FIG. 174.—Lateral Ligament of Right Knee Joint.

Attachments.—Its *femoral* attachments are :—(1) to the sides of the condyles a little distance from the articular margins; and (2) to the back of the femur, along the intercondylar line and immediately above the articular margins of the condyles. Its *tibial* attachments are :—(1) to the posterior surface and the sides of the condyles near the articular margins; and (2) to the anterior surface of the condyles along oblique lines that begin near the articular margins of the sides and run to the sides of the tuberosity of the tibia.

Relations.—The heads of the gastrocnemius and the plantaris overlie the posterior part of the capsule opposite the femoral condyles. The medial head is separated from the capsule by a bursa, but the lateral head and the plantaris are

partly attached to it; and even the popliteus, after it emerges through the capsule, derives some fleshy fibres of origin from it. The tendon of the popliteus perforates the fibrous capsule opposite the back of the lateral condyle of the tibia; at the

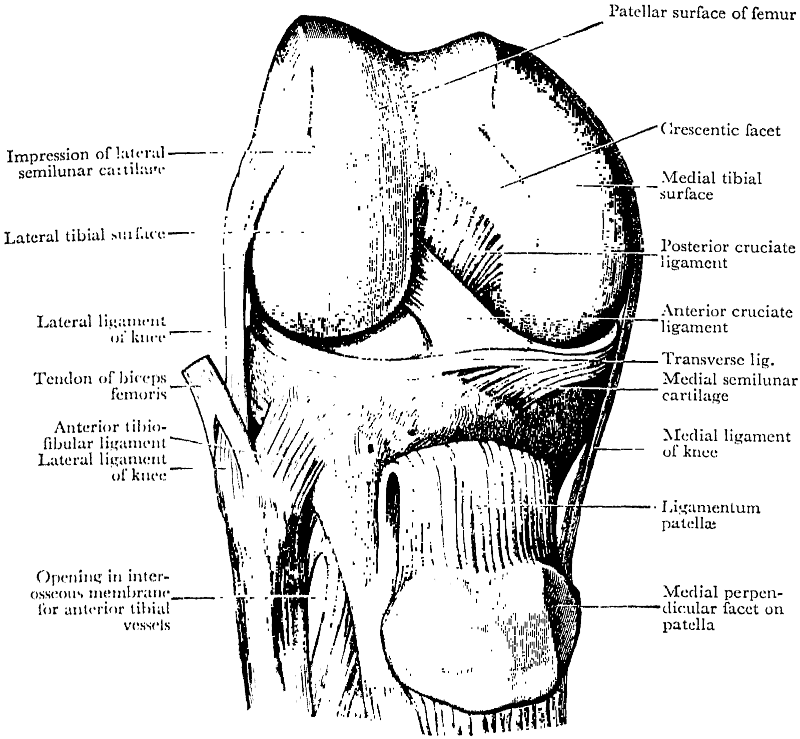

FIG. 175.—Dissection of Interior of Right Knee Joint from the front.

back of the medial femoral condyle there is sometimes a hole in the capsule through which the synovial membrane is continuous with the bursa under the medial head of the gastrocnemius. The fibrous capsule is pierced also by the articular vessels and nerves.

Accessory Parts.—The fibrous capsule is supplemented and strengthened by accessory ligaments, by tendons or expansions from them, and by deep fascia. The ligamentum

patellæ (which is the tendon of the quadriceps) replaces it in front. At the back, it is strengthened by the oblique popliteal ligament. The medial ligament of the joint overlies it on the medial side, and the lateral ligament on the lateral side. In the intervals that separate those two ligaments from the ligamentum patellæ, the capsule is subcutaneous and is strengthened by the fascia lata and expansions from the lateral and medial vasti which fuse with it ; these expansions from the vasti are called the *patellar retinacula*.

Ligamentum Patellæ.—The patellar ligament is a strong, thick band, about two inches long and one inch wide. Its upper end is attached to the apex of the patella and to the lower part of its deep surface. The lower end is attached to the smooth, upper part of the tuberosity of the tibia. Its superficial fibres are directly continuous, over the surface of the patella, with the central part of the common tendon of the quadriceps femoris. The upper part of its deep surface is separated from the synovial membrane by a mass of loose fatty tissue—the *infrapatellar pad of fat*; the lower part is separated from the anterior surface of the upper end of the tibia by the deep infrapatellar bursa (Fig. 177).

Lateral Ligament of Knee.—The lateral (fibular collateral) ligament is a rounded, cord-like band, nearly two inches long. It extends from the lateral epicondyle of the femur to the head of the fibula. Its upper part is fused with the underlying part of the capsule, but most of it is separated from the capsule by fatty tissue through which the inferior lateral genicular vessels pass forward (Fig. 160). It is closely related to the tendon of the biceps femoris and the tendon of the popliteus. The tendon of the biceps overlies its lower part, and is first grooved by it and then split by it. The tendon of the popliteus takes origin from the femur below and in front of the attachment of the ligament. As the tendon runs downwards and backwards, it is deep to the ligament, separated from it by the articular capsule (Fig. 174).

Medial Ligament of Knee.—The medial (tibial collateral) ligament is a long, flat band, broader in the middle than at its ends. It springs from the medial epicondyle of the femur immediately below the adductor tubercle. As it descends, it inclines slightly forwards, and it finally gains attachment to the margin of the medial condyle and to the upper fourth of the shaft of the tibia close to the medial

border. Opposite the interval between the femur and the tibia, it is fused with the fibrous capsule. It is related to the tendons of the semimembranosus, the sartorius, gracilis and semitendinosus ; and the inferior medial genicular vessels pass forwards between its lower part and the tibia.

Oblique Popliteal Ligament of Knee.—The oblique popliteal ligament was found when the insertion of the semimembranosus was examined, and is readily demonstrated if the tendon of the semimembranosus is pulled upon. It is a broad slip that springs from that tendon at the back of the medial condyle of the tibia ; it spreads upwards and laterally towards the lateral femoral condyle, fusing with the fibrous capsule.

Dissection.—Cut across the quadriceps femoris immediately above the patella, prolong each end of the incision downwards, about an inch and a half behind the patella, to the condyles of the tibia, and turn the patella downwards.

Next, split the lower part of the quadriceps, and turn the two parts aside, to expose the *suprapatellar bursa.* Open the bursa, if that was not done when the quadriceps was split. Explore the interior of the bursa and note the size of the opening by which it communicates with the knee joint.

INTERIOR OF KNEE JOINT.—When the joint is laid open in the way prescribed above, we can see the semilunar cartilages, the cruciate ligaments and the synovial membrane, including its infrapatellar fold. The *infrapatellar synovial fold* is, indeed, the first structure to be noticed. It is a triangular fold pinched up from the synovial membrane that covers the mass of fat behind the patellar ligament ; from the apex of the fold, a slender prolongation extends upwards and backwards to be attached to the anterior margin of the intercondylar notch of the femur (Figs. 176, 177) ; and the lower part of each margin of the fold is prolonged sidewards as an uneven ridge named an *alar fold.* The *infrapatellar pad of fat* fills up the interval between the patella, femur and tibia, and adapts itself to the varied forms which that recess assumes in the different movements of the joint.

Synovial Membrane.—As the knee joint is the largest joint in the body, its synovial membrane is more extensive than that of any other joint. It lines the fibrous capsule, and, at the bony attachments of the capsule, it is reflected on to the tibia and femur and extends to the margins of the

articular cartilage, which it overlaps. It therefore covers the non-articular strips of bone that lie within the capsule.

At the sides, it is reflected also on to the upper and lower

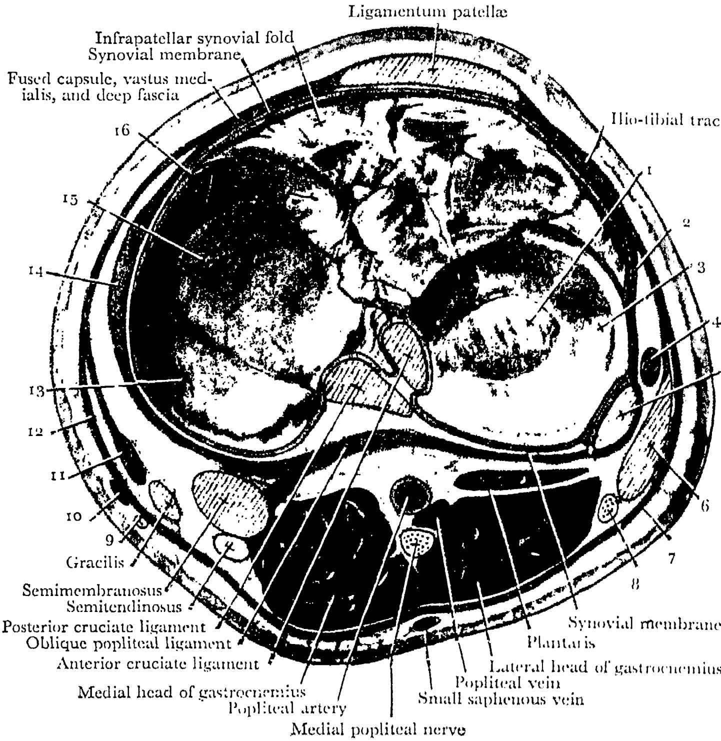

FIG. 176.—Transverse Section through Right Knee Joint and its surroundings. Showing Relations of Synovial Membrane.

1. Lateral condyle of tibia.
2. Fibrous capsule.
3. Lateral semilunar cartilage.
4. Lateral ligament of knee.
5. Popliteus tendon.
6. Biceps femoris.
7. Deep fascia.
8. Lateral popliteal nerve.
9. Saphenous nerve.
10. Great saphenous vein.
11. Sartorius.
12. Deep fascia.
13. Medial semilunar cartilage.
14. Medial ligament of knee.
15. Medial condyle of tibia.
16. Synovial membrane.

surfaces of the semilunar cartilages. Originally, those reflected portions covered the surfaces of these cartilages and met at their free edges; but, in the adult, they thin out at the capsular margins of the cartilages and disappear, for

they have been obliterated by pressure. In the middle part of the back of the joint, the synovial membrane is separated from the capsule by the cruciate ligaments, for they bulge it forwards into the cavity of the joint; the synovial membrane, therefore, covers the sides and the front of the cruciate ligaments, but leaves the posterior one to be connected with the fibrous capsule by areolar tissue (Fig. 176).

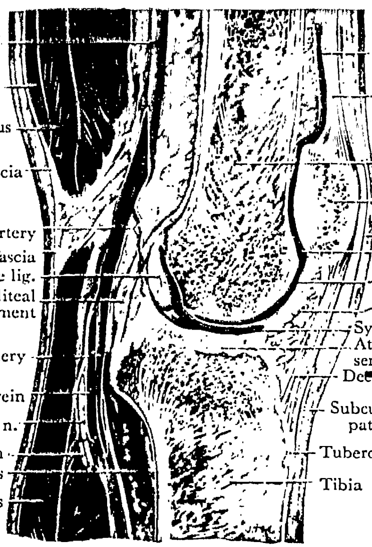

FIG. 177.—Sagittal Section of Right Knee Joint.

At the front of the joint, the synovial membrane is absent from the patella. Below the patella, it covers the posterior surface of the infrapatellar pad of fat, which separates it from the ligamentum patellæ; and it is raised up to form the infrapatellar and alar folds already described. Above the patella, it lines the deep surface of the tendon of the quadriceps extensor. A short distance above the patella, it is reflected off the tendon on to the fat that covers the front of the femur, and extends downwards to overlap the margin of the patellar articular surface of the femur. But the cavity of the joint communicates, by an opening of variable width, with the suprapatellar bursa. That bursa is, in effect, an extension

of the synovial membrane; and the upper limit of the cavity of the joint is therefore about three finger-breadths above the patella, when the joint is in the extended position.

In many subjects, the synovial membrane is continuous with the bursa of the medial head of the gastrocnemius through a hole in the back of the capsule. A tube-like pouch of the synovial membrane lies along the medial side of the intracapsular part of the tendon of the popliteus. The pouch separates the tendon from the lateral condyle of the femur and the margin of the lateral semilunar cartilage (Fig. 176), and may overlap the edges of the tendon; it is carried out of the joint with the tendon, and separates the tendon from the back of the lateral condyle of the tibia and from the back of the superior tibio-fibular joint, with which it sometimes communicates.

Dissection.—Divide the infrapatellar synovial fold and remove the infrapatellar pad of fat. Open and examine the bursa between the ligamentum patellæ and the tibia. Then, turn the limb round, dissect away the intermediate part of the posterior portion of the capsule, and trace the middle genicular artery (which pierces it) forwards to the cruciate ligaments.

Remove the areolar tissue from the back of the cruciate ligaments, and the synovial membrane from their front and sides; and define their attachments to the femur and tibia. Lastly, define the connexions of the semilunar cartilages.

At this stage, the changes produced in the degree of tension of the cruciate ligaments, and the change in the position of the semilunar cartilages brought about by movements of the joint, should be examined.

Movements at the Knee Joint.—The chief movements at the knee joint are flexion and extension. The leg can be bent backwards until the calf comes into contact with the back of the thigh; but in extension the movement is brought to a close when the leg comes into a line with the thigh. In that position the joint is firmly locked; the anterior cruciate, the medial and lateral ligaments, and the posterior part of the capsule with the oblique popliteal ligament are taut; and the leg and thigh are converted into a rigid column of support. In flexion, however, the ligaments mentioned are relaxed, and a considerable amount of rotation is allowed, which is most free when the leg is at right angles to the thigh.

The muscles which operate are:—*Extensors*: the four parts of the quadriceps femoris. *Flexors*: biceps femoris,

popliteus, sartorius, gracilis, semitendinosus and semimembranosus. Of these, only one is inserted on the lateral side of the limb, viz., the biceps. The other five are inserted into the tibia on the medial side of the leg. *Medial rotators*: Popliteus, gracilis, sartorius, semitendinosus and semimembranosus. *Lateral rotator*: biceps femoris.

Flex the joint acutely, and examine the articular surface of the femur. It is divided into a pulley or trochlea for the patella in front, and two condylar parts below. The condylar parts move on the condyles of the tibia and the semilunar cartilages; and they are marked off from the trochlea by faint lines. Another faint line cuts a strip off the medial condyle. This strip skirts the medial border of the anterior part of the intercondylar notch; it also articulates with the patella, and it is called the *crescentic facet* (Fig. 175).

Now, examine the articular surface of the patella. A high but blunt vertical ridge divides it into two parts, of which the lateral is the larger—corresponding to the lateral and larger part of the trochlea. A fainter vertical ridge cuts off a narrow strip along the medial border called the *perpendicular facet*. Two faint horizontal lines divide the rest of the surface into three areas, each of which is subdivided into two facets by the main vertical ridge. When the division of the articular surface is well-marked, seven facets are therefore seen—two upper, two middle, two lower, and the perpendicular (Goodsir [1]).

This division into facets indicates that the entire articular surface is never in contact with the femur at the same time. In flexion and extension, the facets come smoothly into contact with the femur and break contact with it in regular succession. In acute flexion, the crescentic facet of the femur is in contact with the perpendicular facet of the patella, and the lower, lateral part of the trochlea is in contact with the lateral of the two upper facets; but the medial part of the trochlea does not reach low enough to be in contact. As the leg is extended, the upper two facets come into contact with the trochlea, next the middle facets and lastly the lower facets (Goodsir). In Figs. 171, 172, 180B, the varying position of the patella, as shown by X-rays, is seen.

The lateral condylar surface of the femur is shorter than the medial, and is therefore sooner used up in the movement of extension. To bring the unused part of the medial condylar surface into play, lateral rotation of the tibia on the femur takes place; and that gives rise to the "screw-home" movement, which is characteristic of the final stage of extension at the knee joint.

When fully extended, the joint is "screwed home" or locked; in that position the anterior cruciate ligament, the lateral and medial ligaments, and the posterior part of the capsule are all tense; the limb is now a rigid column, and the upright posture is maintained with the least possible muscular effort, for the line from the centre of gravity falls in front of the knee. At the beginning of flexion, the screwing movement is reversed by medial rotation of the leg brought about chiefly by the popliteus.

In the ordinary movements of the knee joint, as in walking, the lower part of the limb is more fixed than the upper, and the thigh moves

[1] John Goodsir, Professor of Anatomy, University of Edinburgh, 1846–1867.

on the leg rather than the leg on the thigh. In all these movements, the condyles of the femur glide as well as rotate—like " a wheel partially restrained by a drag " (Goodsir).

An account of the part played by the semilunar cartilages and a fuller account of the relations of the bones to one another are given in the large Text-books of Anatomy. In reading a full account, the student must not lose sight of the fact that the knee joint is essentially a hinge. The bolt of the hinge passes through the femoral attachments of the

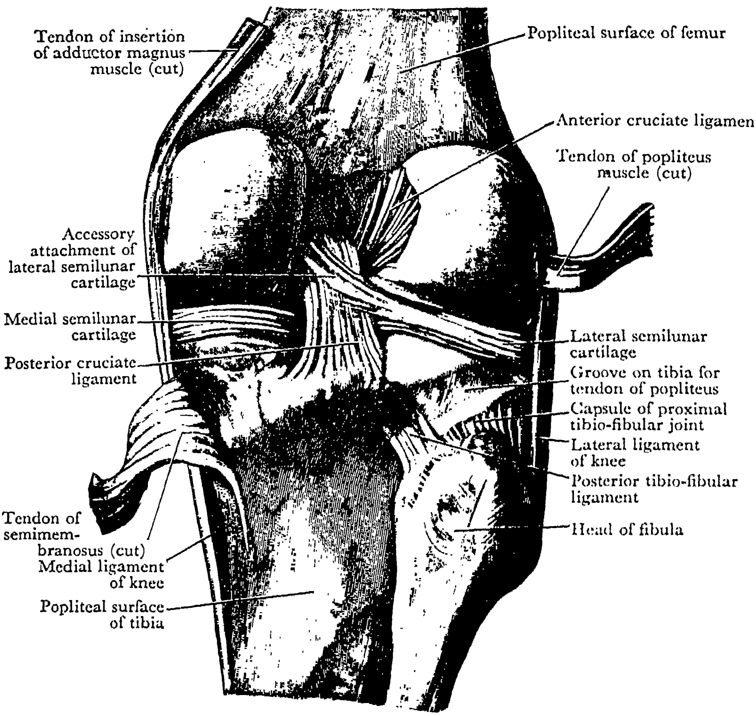

FIG. 178.—Right Knee Joint opened from behind by removal of posterior part of Capsule.

lateral, medial and cruciate ligaments; subject to the control of muscles, the ligaments suspend the leg after the manner of the ropes of a swing, and some rotation is therefore possible as soon as they are relaxed.

Dissection.—In order to obtain a proper view of the attachments of the cruciate ligaments, saw the femur across about two inches above its distal articular surface, and divide the distal part of the bone by a sagittal saw-cut that ends in the intercondylar notch between the two cruciate ligaments.

PLATE XXXVII

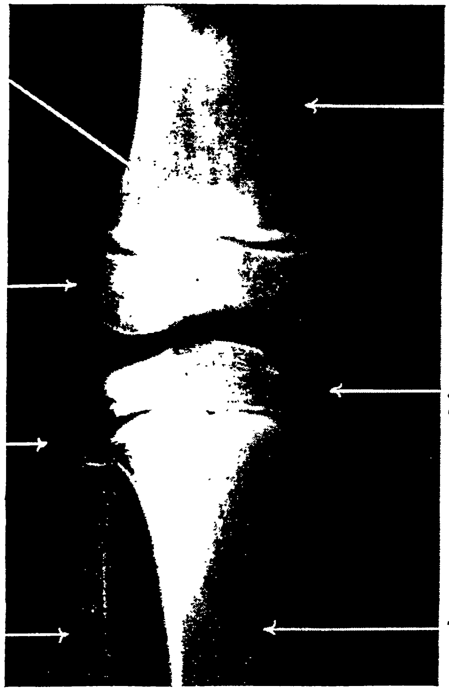

FIG. 179A.—Radiograph of Knee of boy aged 7. Note the size of the patella and its position in comparison with Fig 179B.

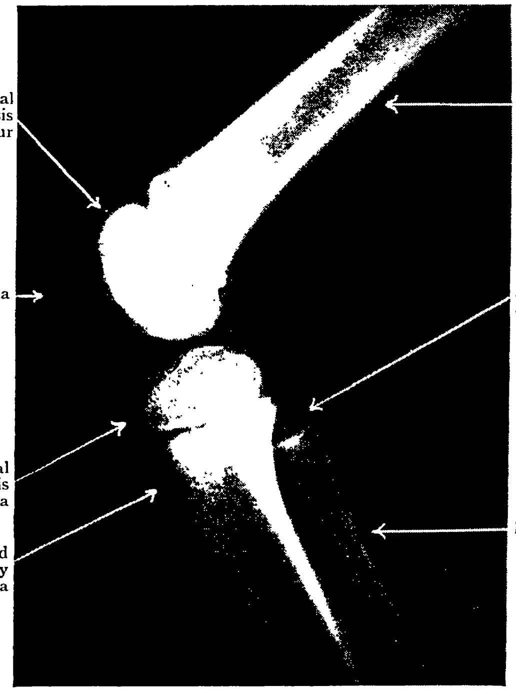

FIG. 179B.—Lateral Radiograph of the same Knee in semi-flexed position. Note that centre for tuberosity of tibia has not appeared and compare with Fig. 180B.

[*Facing p.* 356

PLATE XXXVIII

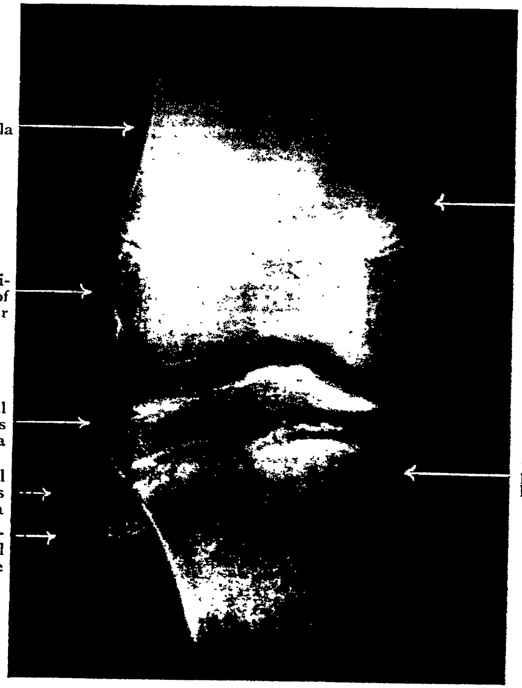

FIG. 180A.—Radiograph of Knee of boy aged 12.

Note the position of the patella in comparison with Fig. 180B.

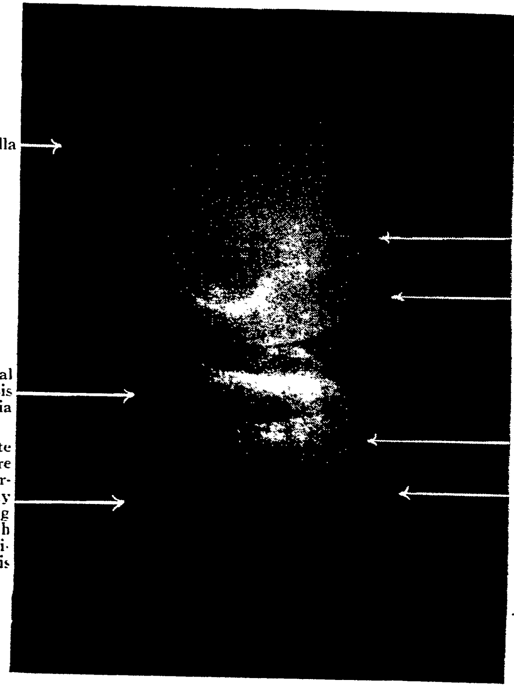

FIG. 180B.—Lateral Radiograph of the same Knee in slightly flexed position.

Note the extension of the tibial epiphysis to the tuberosity, probably ossified in this instance from a separate centre. *Cf.* Fig. 179B.

[*Facing p.* 357

The cruciate ligaments can, at this stage, be studied singly or together, and their relation to the ligaments at the sides of the joint can be examined. The lateral ligament of the joint and the anterior cruciate ligament are fixed to opposite sides of the lateral condyle. The medial ligament and the posterior cruciate ligament are attached to the opposite sides of the medial condyle. When that relationship has been noted, divide the medial ligament of the joint, in order to free the medial condyle and to give greater space for the study of the cruciate ligaments.

Cruciate Ligaments of Knee.—The cruciate ligaments are so named because they cross each other like the limbs of the letter X. This crucial arrangement is seen whether they are viewed from the side or the front or the back.

The *anterior cruciate ligament* springs from the anterior part of the intercondylar area on the upper surface of the tibia, and proceeds upwards, backwards and laterally, to gain attachment to the posterior part of the medial surface of the lateral condyle of the femur (Figs. 175, 178).

The *posterior cruciate ligament* springs from the posterior part of the intercondylar area. It passes upwards, forwards and a little medially, and crosses the anterior cruciate ligament obliquely to be attached to the anterior portion of the lateral surface of the medial condyle (Fig. 175). It receives one or sometimes two strong slips from the posterior horn of the lateral semilunar cartilage (Fig. 178).

The anterior cruciate ligament is tight *in extension* of the knee joint, and the posterior *in flexion*.

Semilunar Cartilages.—The semilunar cartilages (menisci) are two crescentic plates of fibro-cartilage which are placed on the condylar surfaces of the tibia. Each has two fibrous extremities or *horns* which are attached to the intercondylar area on the proximal surface of the tibia. The semilunar cartilages deepen the surfaces upon which the condyles of the femur roll, and, being movable, they fill up the gaps which would otherwise arise during the movements of the joint. They are thick towards the circumference of the joint—the lateral a little thicker than the medial—but thin away to a fine, free, concave edge towards the centre. Both surfaces are smooth and articular. They do not cover the entire extent of the condylar surfaces of the tibia. The central parts of those surfaces, as well as the sloping surfaces of the tubercles

of the intercondylar eminence, are free. When the cartilages are raised from the surface, distinct impressions, similar in shape and extent, are seen on the articular cartilage of the tibia.

Dissection.—**Carefully define the attachments of the fibrous horns of the semilunar cartilages.**

The **lateral semilunar cartilage** is an almost complete circle, for its horns are fixed to the tibia close together. The

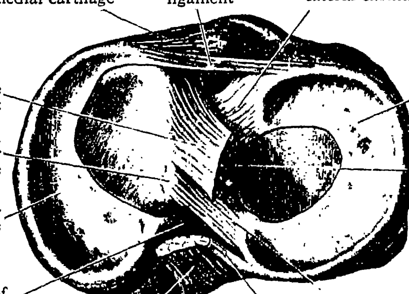

FIG. 181.—Parts attached to Proximal Surface of Right Tibia.

anterior horn is attached to the tibia immediately in front of the intercondylar eminence, lateral to the anterior cruciate ligament, and partly under cover of it. The *posterior horn* is fixed to the summit of the intercondylar eminence. It gives a strong slip also to the posterior cruciate ligament.

The lateral ligament of the knee is separated from the lateral semilunar cartilage by the capsular ligament and by the tendon of the popliteus and its synovial pouch. The tendon grooves the posterior part of the lateral border of the cartilage, but behind and in front of the groove the peripheral margin of the cartilage is blended with the fibrous capsule.

The **medial semilunar cartilage** is semicircular in outline, and forms the segment of a much larger circle than the lateral one does. Its *anterior horn* is fixed to the most anterior part of the intercondylar area, in front of the attachment of the

anterior cruciate ligament. Its *posterior horn* is attached in the intercondylar area, behind the intercondylar eminence and in front of the attachment of the posterior cruciate ligament. The greater part of the peripheral border of the medial semilunar cartilage is closely connected with the fibrous capsule.

Through their connexions with the fibrous capsule both the semilunar cartilages gain attachment to the distal end of the femur and the proximal end of the tibia.

The **transverse ligament of the knee** is a fibrous band which stretches across from the anterior part of one semilunar

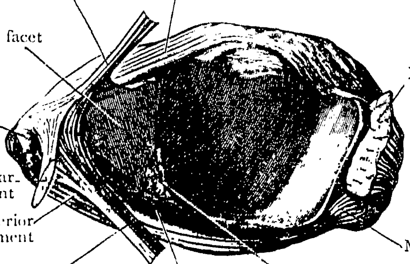

FIG. 182.—Surfaces of Right Tibia and Fibula which articulate with Talus.

cartilage to the corresponding part of the other, and by means of it the one cartilage is partly controlled and partly accompanied by the other in its displacement during the movements of the femur on the tibia.

> ***Dissection.*—Divide the lateral ligament, the cruciate ligaments, and the remains of the capsular ligament close to their femoral attachments, and examine the tibial attachments of the cruciate ligaments and semilunar cartilages.**

Injuries to Semilunar Cartilages.—The commonest cause of "internal derangement of the knee joint" is injury to one of the semilunar cartilages, and the most frequent injuries are displacement, transverse rupture or longitudinal splitting of the *medial* cartilage. These accidents occur in the partly flexed position of the knee, and are usually caused by sudden, forcible lateral rotation or abduction of the tibia, as often happens in the game of football. The displaced or torn cartilage may be wedged between the articular surfaces so that the joint is "locked". Injury to the lateral cartilage is much less frequent on account of its shape, its looser attachment to the capsule and consequent greater mobility.

Ankle Joint

The **ankle joint** is a synovial joint of the hinge variety. It is a joint of great strength; its stability is ensured not only by its powerful ligaments and the tendons around it, but

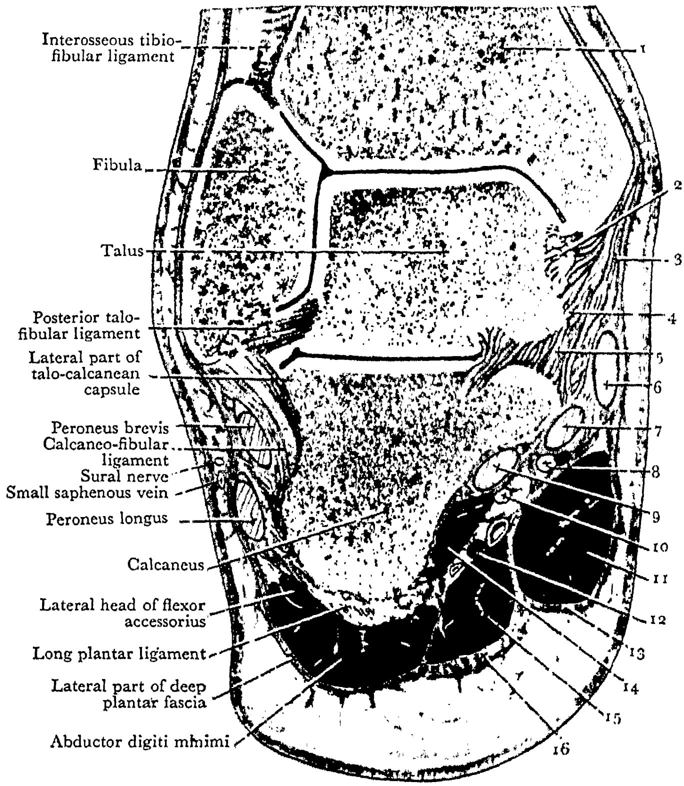

Fig. 183.—Oblique Coronal Section through Ankle Joint and Talo-Calcanean Joint.

1. Tibia.
2. Deep fibres of deltoid ligament.
3. Superficial fibres of deltoid ligament.
4. Deep fibres of deltoid ligament.
5. Deep fibres of deltoid ligament continuous with interosseous talo-calcanean ligament.
6. Tibialis posterior.
7. Flexor digitorum longus.
8. Medial plantar nerve and artery.
9. Flexor hallucis longus.
10. Lateral plantar nerve.
11. Abductor hallucis.
12. Lateral plantar artery.
13. Medial part of deep plantar fascia.
14. Medial head of flexor accessorius.
15. Flexor digitorum brevis.
16. Plantar aponeurosis.

also by the close interlocking of the articulating surfaces.

The bones which enter into the formation of the ankle joint are the talus and the distal ends of the tibia and fibula. The talus articulates with the bones of the leg by three of its surfaces—upper, medial and lateral. The distal ends of the

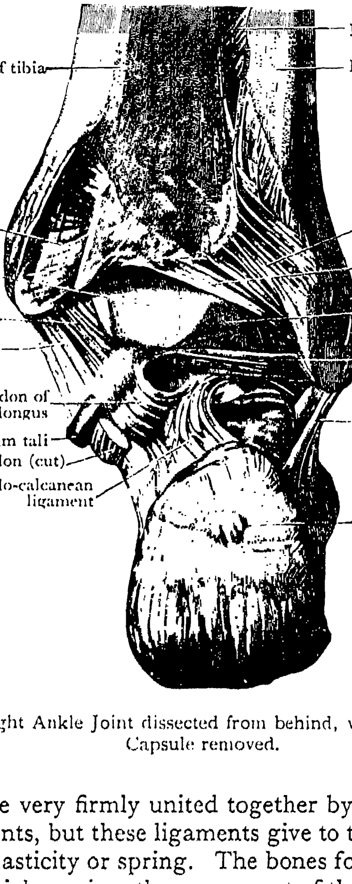

FIG. 184.—Right Ankle Joint dissected from behind, with part of Articular Capsule removed.

leg bones are very firmly united together by interosseous and other ligaments, but these ligaments give to the joint a certain amount of elasticity or spring. The bones form a deep hollow or socket which receives the upper part of the talus (Fig. 187). The socket is slightly deepened posteriorly by the *transverse tibio-fibular ligament* (Figs. 182, 184), which springs from the fossa of the lateral malleolus and widens to be attached to the posterior border of the distal end of the tibia.

Dissection.—Remove the remains of the flexor and extensor retinacula, and cut through and displace the tendons which are in relation with the joint, but do not remove them. Review the anastomoses between the arteries around the joint (p. 325), and, if possible, secure the twigs from the anterior and posterior tibial nerves which supply the joint. Then clean carefully the anterior and posterior ligaments of the joint, both of which are extremely thin and easily injured.

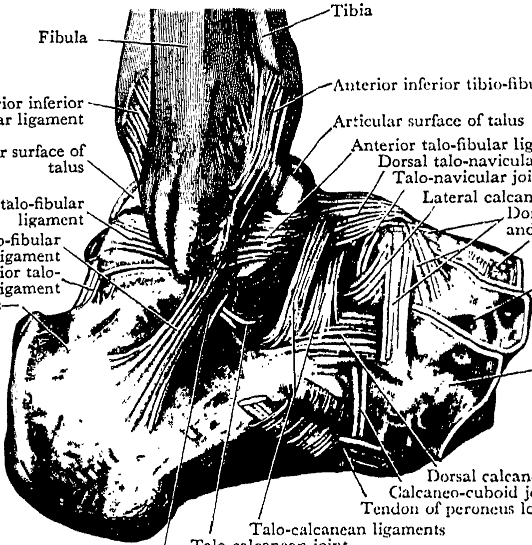

FIG. 185.—Ligaments on lateral aspect of Right Ankle Joint and on Dorsum of Tarsus.

LIGAMENTS OF ANKLE JOINT.—The joint is surrounded by a capsular ligament which, in conformity with the movements of a hinge-joint, is weak in front and behind (anterior and posterior ligaments) and very strong at the sides (medial and lateral ligaments).

Articular Capsule.—The ligaments are joined together by their edges, and form the fibrous capsule of the joint. The medial ligament, which has several lower attachments other than to the talus, is greatly thickened and is called the *deltoid ligament*. The lateral ligament is usually described as consisting of three strong bands. Two of them, the *anterior* and *posterior talo-fibular ligaments* are thickenings of the capsule ;

but the middle band, the *calcaneo-fibular ligament*, is separated from the lateral part of the capsule by some fatty tissue and extends from the fibula beyond the talus to the calcaneus.

The **anterior ligament** of the ankle joint, thin, wide and membranous, is composed chiefly of transverse fibres. It

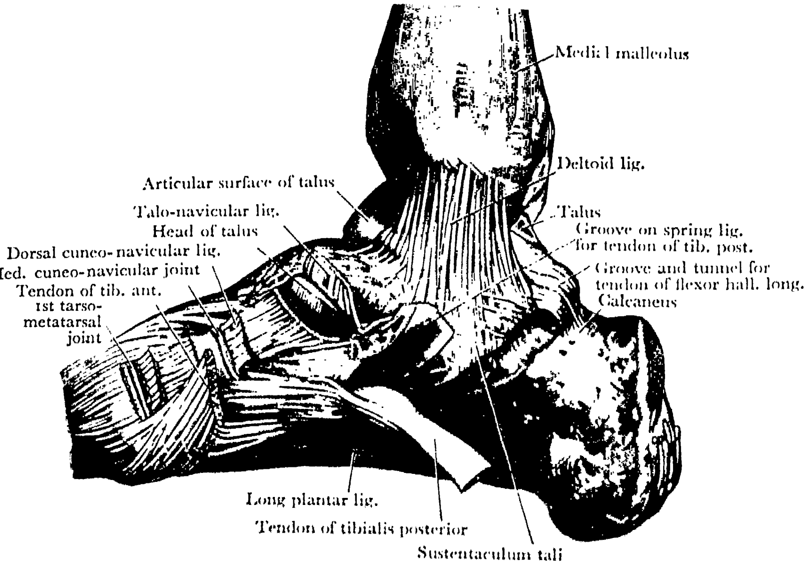

FIG. 186.—Right Ankle and Tarsal Joints from the medial side.

extends from the anterior margin of the distal surface of the tibia to the anterior part of the dorsal surface of the neck of the talus. Therefore, a cut across the foot, immediately in front of the tibia, may open the ankle joint (see Fig. 189).

The **posterior ligament** also is composed chiefly of transverse fibres. It is very short, and is so thin that it is difficult to define it, and it is often incomplete. It extends from the posterior border of the distal end of the tibia and the transverse tibio-fibular ligament to the posterior surface of the talus.

Dissection.—Remove the anterior and posterior ligaments in order to bring the ligaments on the sides of the joint more fully into relief. Clean these ligaments and define their attachments.

PLATE XXXIX

FIG. 187A.—Antero-posterior Radiograph of Ankle and Tarsus of young man aged 22. Note that the superimposition of the tarsal bones makes it difficult to distinguish them. Cf. Fig. 187B.

FIG. 187B.—Lateral Radiograph of the same Ankle and Tarsus.

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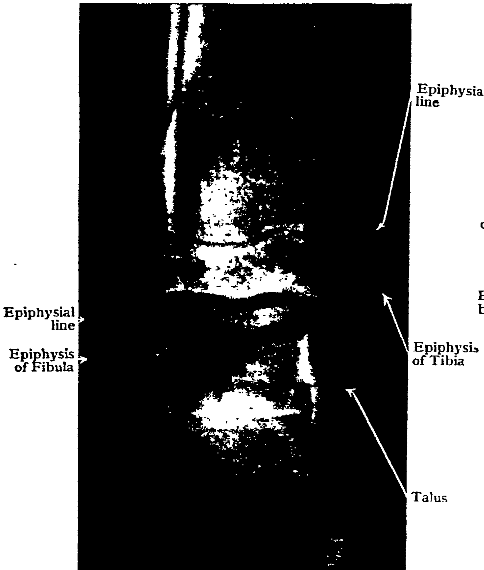

FIG. 188A.—Antero-posterior Radiograph of Ankle of girl aged 12.

Cf. Fig. 187A, and note the relation of the epiphyses of Tibia and Fibula to the malleoli and to the ankle joint.

FIG. 188B.—Lateral Radiograph of the same Ankle and Foot.

Cf. Fig. 194 for the development of the epiphysis of the Calcaneus.

[Facing p. 365

Anteriorly, the following principal structures are found from the medial to the lateral side :—the tibialis anterior, the extensor hallucis longus, the anterior tibial vessels and nerve, and the extensor digitorum longus with the peroneus tertius (Fig. 148, p. 297).

Behind the joint, from the medial to the lateral side, the structures in close relation with the capsule are :—the flexor digitorum longus, the posterior tibial vessels and nerve, and the flexor hallucis longus. The tendo calcaneus is farther back and is separated from the flexor hallucis longus and the joint by a large pad of fat.

On the medial side, the tibialis posterior lies on the deltoid ligament, and the flexor digitorum longus lies on the attachment of that ligament to the sustentaculum tali. *On the lateral side*, the peroneus longus and brevis cross the calcaneo-fibular ligament.

Dissection.—Cut through the anterior talo-fibular ligament, the calcaneo-fibular ligament, and the anterior part of the deltoid ligament ; separate the articular surfaces and examine them.

Articular Surfaces of Ankle Joint.—The proximal articular area is formed by the talar surfaces of the tibia and malleoli. These three surfaces together form the boundaries of a socket. It is important to note that the socket is wider in front than it is behind. The distal articular area is formed by the upper surface of the body of the talus and the articular parts of its medial and lateral surfaces. It also is broader in front than behind ; and it fits into the socket formed by the bones of the leg. Note the special bevelled facet on the postero-lateral corner of the upper surface of the talus for the transverse tibio-fibular ligament (p. 368), which deepens the socket behind (Fig. 184).

Movements.—The movements are dorsi-flexion and plantar-flexion or "extension", and also a little side-to-side movement when the joint is plantar-flexed.

When the joint is *dorsi-flexed*—that is, when the foot is turned upwards—the broad part of the distal articular area rotates backwards into the narrow part of the socket and the joint becomes locked. When the joint is *plantar-flexed*—that is, when the foot is turned downwards—the narrow part of the distal articular area moves forwards into the wide part of the socket, and a small amount of *side-to-side movement* becomes possible.

As the articular surfaces are broader in front than behind, it follows that the more completely the ankle joint is dorsi-flexed, the more tightly will the talus be grasped between the two malleoli. In the erect position, the talus is held firmly in the bony socket, and portions of its articular surface project both in front of and behind the tibia. The line of the centre of gravity falls in front of the ankle joint, and as a result the bones are kept firmly locked.

In *dorsi-flexion*, the calcaneo-fibular and posterior talo-fibular bands, the greater part of the deltoid ligament, and the posterior part of the capsule are put on the stretch. In *plantar-flexion*, the anterior talo-fibular ligament, the anterior fibres of the deltoid ligament, and the anterior part of the capsule are tense.

The **muscles** principally concerned in producing *dorsi-flexion* are the tibialis anterior, the extensor digitorum longus, the extensor hallucis longus and the peroneus tertius; the *plantar-flexors* are the superficial muscles of the calf, the tibialis posterior, the long flexors of the toes, and the peroneus longus and brevis.

Tibio-Fibular Joints

The fibula articulates with the tibia by both of its ends. The *proximal tibio-fibular joint* is a synovial joint. The *distal joint* is a syndesmosis—that is, the bones are held together by ligaments that do not enclose a cavity, and the only movements possible are those allowed by slight stretching and twisting of the ligaments. The *interosseous membrane* is common to both joints.

***Dissection.*—Preparatory to the examination of the tibio-fibular joints, remove the foot by dividing the remains of the ligaments of the ankle joint. Clean and define the ligaments that connect the ends of the fibula with the tibia. Detach the muscles from the bones of the leg and from both surfaces of the interosseous membrane, and clean the membrane.**

Interosseous Membrane of Leg.—This strong membrane stretches across the interval between the tibia and the fibula, and greatly extends the surface for the origin of muscles. It is attached to the interosseous borders of the two bones. It is composed of strong, oblique fibres which run downwards and laterally from the tibia to the fibula. In the upper part of the membrane, immediately below the lateral condyle of the tibia, there is an oval opening for the passage of the anterior tibial vessels; and a small aperture, a short distance above the ankle joint, transmits the perforating branch of the

peroneal artery. The tibialis posterior and flexor hallucis longus take partial origin from the back of it; the tibialis anterior, long extensors of the toes and peroneus tertius from the front. The membrane is supplied by a branch from the nerve to the popliteus.

Proximal Tibio-Fibular Joint.—At this joint, the head of the fibula articulates with the lateral condyle of the tibia. The bones are united by a fibrous capsule attached near the margins of the articular facets. This capsule is strengthened,

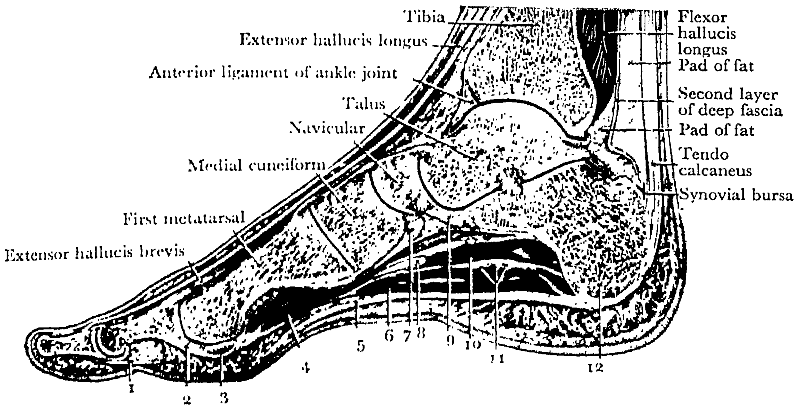

FIG. 189.—Oblique Sagittal Section through the Foot from the middle of the heel to the middle of the big toe.

1. Flexor hallucis longus.
2. Plantar metatarso-phalangeal lig.
3. Sesamoid bone.
4. Flexor hallucis brevis.
5. Plantar fascia.
6. Flexor digitorum brevis.
7. Tibialis posterior tendon.
8. Flexor digitorum longus tendon.
9. Plantar calcaneo-navicular lig.
10. Flexor accessorius.
11. Lateral plantar vessels and nerve.
12. Calcaneus.

in front and behind (especially in front), by oblique fibres that run downwards and laterally from the tibia to the head of the fibula. The tendon of the popliteus and its synovial pouch cross the upper part of the back of the joint, and the pouch sometimes is continuous with the synovial membrane of the joint through a hole in the capsule; in this way the joint may be indirectly in communication with the knee joint. The lateral ligament of the knee and the tendon of the biceps cross the upper surface of the joint.

The joint is supplied by twigs from the nerve to the popliteus and the recurrent genicular nerve.

Distal Tibio-Fibular Joint (Figs. 182, 183-185).—This joint—the *tibio-fibular syndesmosis*—is constructed upon a stronger plan, because the strength of the ankle joint very largely depends upon its integrity.

The joint is formed between the rough surface on the medial side of the lower end of the fibula and the fibular notch of the tibia. The bones, however, are not in contact with each other, but separated by the interosseous ligament which binds them together. Sometimes the interosseous ligament does not quite reach the lateral border of the distal end of the tibia. In such cases, there is a narrow strip coated with cartilage for articulation with the uppermost part of the articular facet of the lateral malleolus.

In addition to the interosseous ligament, there are ligamentous bands in front of and behind the joint, and a transverse tibio-fibular ligament which has a special relation to the ankle joint.

The **interosseous ligament** is the chief bond at this joint. It is thick and very strong, and is composed of short fibres that pass between the opposing bony surfaces.

The **anterior inferior** and **posterior inferior tibio-fibular ligaments** are strong, flat bands that pass upwards and medially from the front and the back of the uppermost part of the lateral malleolus to the distal end of the tibia. They conceal the interosseous ligament. The posterior ligament is continuous inferiorly with the transverse ligament.

The **transverse tibio-fibular ligament** is a strong, narrow band of yellowish fibres attached to the whole length of the posterior border of the distal surface of the tibia and to the malleolar fossa of the fibula. It projects downwards as a lip from the posterior border of the socket of the ankle joint (Figs. 182, 184) and articulates with the special facet of the talus already mentioned.

> ***Dissection.***—To see the interosseous ligament and appreciate its shortness and thickness, saw across the bones of the leg about two inches from the distal end of the tibia, and then split them by a coronal saw-cut. The interosseous ligament will then be seen, and also the narrow articular interval between the distal portions of the bones, when it exists.

Joints of the Foot

The joints of the foot are very numerous. All the bones of the foot—tarsal and metatarsal bones and phalanges—enter into their formation; and they are classified therefore as :—

1. Intertarsal joints.
2. Tarso-metatarsal joints.
3. Intermetatarsal joints.
4. Metatarso-phalangeal joints.
5. Interphalangeal joints.

Arches of the Foot.—The tarsal and metatarsal bones are bound together by ligaments, and are disposed in the form of two arches, viz., a longitudinal and a transverse. The integrity of these arches is maintained :—(1) partly by the shape of the bones; (2) partly by the tension of the ligaments and the plantar aponeurosis; and (3) most important, by muscular action in which both the short muscles of the sole and the long muscles, through the bracing action of their tendons, take a share.

The **longitudinal arch** presents a greater height and a wider span along the medial side of the foot than along the lateral side. The talus lies at the summit of this arch and, in a sense, is its "keystone" (Fig. 189). The *posterior pillar* is short and solid, being formed by the calcaneus alone. The *anterior pillar*, much longer, comprises the rest of the tarsal bones, and the metatarsus. Further, the anterior pillar is divided into a medial column composed of the navicular, the three cuneiform, and the medial three metatarsal bones, and a lateral column composed of the cuboid and the lateral two metatarsals.

The weight of the body is transmitted to the talus in the summit of the arch, and the most important ligaments concerned in the prevention of flattening of the arch lie in the plantar concavity; they are the *plantar calcaneo-navicular* ("spring") *ligament*, the *long plantar ligament* and the *short plantar ligament*. The various slips of the *tendon of the tibialis posterior*, as they pass to find attachment to the different tarsal and metatarsal bones, give additional support, as also does the *tendon of the peroneus longus*, which crosses the foot obliquely from lateral to medial side. The *plantar aponeurosis* also is an important factor, for, as it extends between the two pillars and is attached to both, it operates,

as Humphry[1] pointed out, in the same manner as the "tie-beam" of a roof.

The **transverse arch** of the foot is seen to best advantage across the line of the tarso-metatarsal articulations.

***Dissection.*—Remove all the muscles and tendons from the tarsus and metatarsus. Clean and define the ligaments on the various surfaces.**

Joints of the Talus.—The talus articulates with the bones of the leg by its upper surface and its sides. Its lower surface articulates with the calcaneus and the plantar calcaneo-navicular ligament (spring ligament). Anteriorly, its head articulates with the navicular bone. It takes part, therefore, in three joints, namely, the *ankle* joint, the *talo-calcanean* joint and the *talo-calcaneo-navicular* joint. The ligaments that hold it in its place are :—(1) the fibrous capsule of the ankle joint, (2) the talo-navicular ligament, which is part of the capsule of the talo-calcaneo-navicular joint, and (3) the fibrous capsule of the talo-calcanean joint. The anterior part of this capsule is very thick and strong ; it is called the interosseous talo-calcanean ligament, and is the chief agent in holding the talus in place.

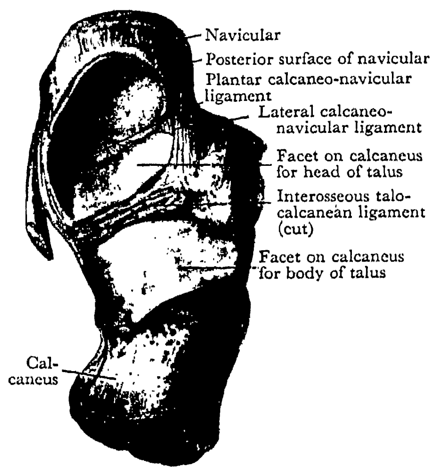

FIG. 190.—Socket for Head of Talus.

Talo-Calcanean Joint.—This is a simple, gliding synovial joint between the large facet on the lower surface of the talus and the corresponding facet on the middle of the upper surface of the calcaneus. It is surrounded by a fibrous capsule, which is attached to the bones near the margins of the arti-

[1] Sir George Murray Humphry, Professor of Anatomy, University of Cambridge, 1866–1883 ; Professor of Surgery, 1883–1896.

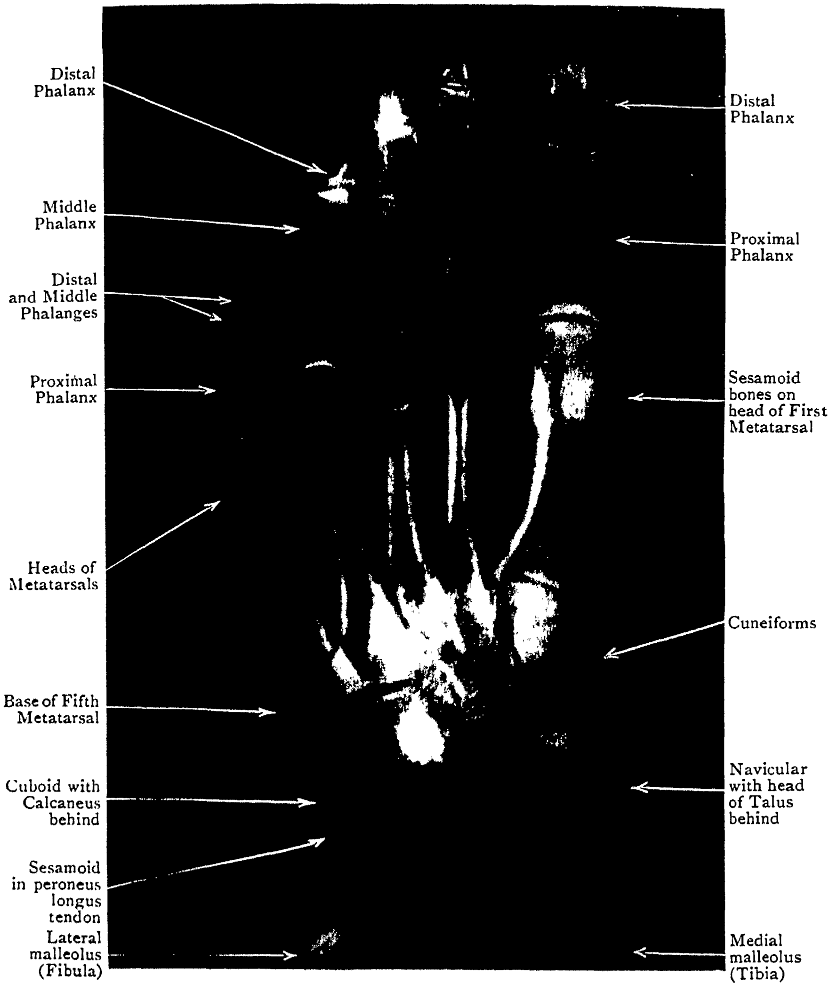

FIG. 191.—Radiograph of Foot of man aged 48. The foot was plantar-flexed, with the sole against the film-container.

PLATE XLII

FIG. 192A.—Radiograph of Foot of boy aged 7. Cf. Fig. 94A, p. 182, noting that the Tarsus is more advanced in ossification than the Carpus, but that the Phalanges of the toes are less advanced than those of the fingers.

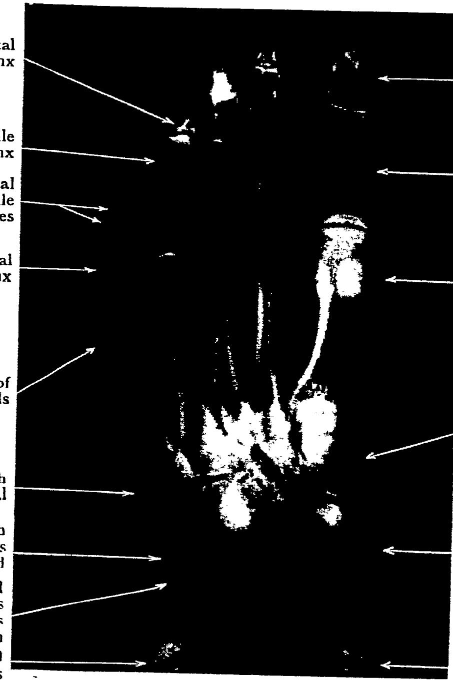

FIG. 192B.—Radiograph of Foot of man aged 48. Compare with Fig. 192A for the identification and relative position of the tarsal bones.

[Facing p. 371

cular facets. The deltoid and calcaneo-fibular ligaments of the ankle joint act as accessory ligaments to this joint.

The **interosseous talo-calcanean ligament** (Fig. 190) lies in the sinus tarsi (*i.e.*, the tunnel between talus and calcaneus), between the talo-calcanean and talo-calcaneo-navicular joints, forming part of the fibrous capsules of both joints. It is attached to the grooves on the contiguous surfaces of the talus and the calcaneus; and it thickens at the lateral end of the sinus, where it is reinforced by the attachment of the stem of the inferior extensor retinaculum (p. 298). It is this lateral, stronger part of the interosseous ligament that is its essential feature, since it forms a pivot for the movements of inversion and eversion (p. 376) between the talus and the calcaneus (Wood Jones).

Talo-Calcaneo-Navicular Joint.—The construction of this joint is peculiar; but, in a way, it is fashioned after the manner of a ball-and-socket joint. The ball is the anterior part of the talus. The socket (Fig. 190) is made up of (1) the anterior part of the calcaneus, including the sustentaculum tali, (2) the plantar calcaneo-navicular or "spring" ligament, and (3) the navicular bone.

The **fibrous capsule** around the joint is composed of a number of named ligaments continuous with each other at their edges. Thus: the lowest fibres of the *deltoid ligament* close the joint medially; the *interosseous talo-calcanean ligament* forms the postero-inferior part of the capsule; a band of fibres called the *lateral calcaneo-navicular ligament* closes the joint laterally; and the *talo-navicular ligament* forms the upper part of the capsule.

The **talo-navicular ligament** is composed of short fibres that pass across the joint from the upper surface of the head of the talus to the upper surface of the navicular bone.

Dissection.—Divide the various ligaments which hold the talus in place, and remove the bone. Clean the divided *interosseous ligament*, and examine its attachment on both the talus and the calcaneus. Clean the *lateral calcaneo-navicular ligament* on the lateral margin of the socket.

Examine the *talus*, and note:—(1) The large facet on the lower surface for articulation at the talo-calcanean joint. (2) The convex surface in front for articulation with the navicular. (3) An elongated facet on the lower surface of the head, neck, and body for articulation with the upper surface of the

anterior part of the calcaneus and of the sustentaculum tali; it may be divided into two parts by a ridge or by a groove. (4) A triangular facet, between 2 and 3, for articulation with the spring ligament.

Examine also the corresponding parts of the *calcaneus* and of the *socket for the head of the talus*; the facet on the sustentaculum tali is frequently cut off from the rest of the anterior articular surface of the calcaneus by a synovial band.

Calcaneo-Navicular Ligaments.—Although the calcaneus does not articulate with the navicular bone, it is connected with it by two powerful ligaments, viz., the plantar and lateral calcaneo-navicular ligaments.

The **plantar calcaneo-navicular ligament,** or "spring" ligament, is a triangular sheet, thick and dense — almost fibro-cartilaginous in texture—that plays an important part in maintaining the longitudinal arch of the foot. It stretches from the anterior margin of the sustentaculum tali to the plantar surface of the navicular bone, and fills up the angular interval between the two bones.

The head of the talus rests on it. The deltoid ligament is attached to its medial margin and braces it up. The tendon of the tibialis posterior is in close contact with it and supports it inferiorly; and, lateral to that, it is separated only by a little fat from the tendons of the long flexors at their point of crossing each other.

The **lateral calcaneo-navicular ligament** is placed deeply in the anterior part of the depression between the calcaneus and the head of the talus; it is the medial part of a V-shaped band, called the *bifurcate ligament*, which springs from the calcaneus and immediately divides into the lateral calcaneo-navicular ligament and the medial calcaneo-cuboid ligament. The lateral calcaneo-navicular ligament stretches from the anterior part of the upper surface of the calcaneus to the lateral surface of the navicular bone; it forms a part of the socket for the head of the talus.

Calcaneo-Cuboid Joint.—In the calcaneo-cuboid joint, the anterior surface of the calcaneus articulates with the posterior surface of the cuboid. It is a distinct joint—that is, its cavity does not communicate with the cavities of neighbouring joints.

The **fibrous capsule** surrounds the joint, and is subdivided into three parts, namely, the dorsal and medial

calcaneo-cuboid ligaments and the short plantar ligament. The capsule is supplemented, on its plantar aspect, by the long plantar ligament.

The *medial calcaneo-cuboid ligament* is the lateral part of

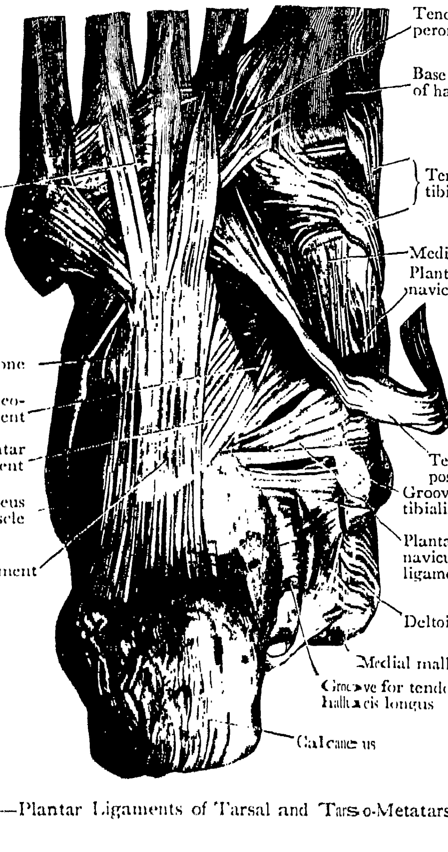

FIG. 193.—Plantar Ligaments of Tarsal and Tarso-Metatarsal Joints.

the "bifurcate ligament". It springs from the anterior part of the upper surface of the calcaneus and passes to the medial surface of the cuboid bone.

The *dorsal calcaneo-cuboid ligament* is a thin ribbon made of short fibres that pass between the dorso-lateral surfaces of the calcaneus and the cuboid.

The long plantar ligament is a long, strong band whose

importance in maintaining the arch of the foot is surpassed only by that of the spring ligament.

It has a wide attachment on the plantar surface of the calcaneus, in front of the medial and lateral tubercles. It extends forwards to be attached to both lips of the groove on the cuboid bone, and its superficial fibres are prolonged into slips that are fixed to the bases of the second, third, and fourth metatarsal bones. The part of it that bridges across the groove of the cuboid forms a fibrous sheath for the tendon of the peroneus longus and holds it in place.

Dissection.—Define the margins of the long plantar ligament. Slip the knife between the ligament and the anterior part of the calcaneus, and carry it backwards, detaching the ligament from the bone. Turn the ligament forwards to expose the short plantar ligament, and clean that ligament.

The *short plantar ligament* (plantar calcaneo-cuboid) is placed under cover of the long plantar ligament—all except its medial edge. It is a wide band composed of strong fibres, nearly an inch in length. They spring from the anterior part of the plantar surface of the calcaneus, and extend to the plantar surface of the cuboid behind its ridge. The ligament is broader than the long plantar ligament and could be seen at the medial border of the latter before it was reflected.

Transverse Tarsal Joint.—The talo-navicular and calcaneo-cuboid joints are quite separate from each other; but they lie very nearly in the same transverse plane (Figs. 188B, 195) and together are often called the "*transverse tarsal joint*". Amputation of the distal part of the foot can be easily carried out at this joint without the division of any bone (Fig. 196); but the surgeon now prefers other operations that give better functional results. Owing to the slope of the foot, the talo-navicular joint is above the calcaneo-cuboid joint, as well as medial to it; and it is noteworthy, in relation to the part that these joints play in the movements of *inversion* and *eversion* of the foot (p. 376), that the ligaments that cross the transverse tarsal joint are, with the exception of the talo-navicular, all attached behind to the calcaneus.

Smaller Joints of Tarsus.—The remaining joints of the tarsus are of relatively small size compared with those described already, and they are of less importance, for the bones are so tightly bound together that movement between them is very little; the bones are all united by *dorsal* and *plantar* ligaments, and the rough parts of their contiguous surfaces give attachment to *interosseous* ligaments. The joints are named after the bones which form them—*cuneo-navicular, intercuneiform, cuneo-cuboid* and *cubo-navicular*.

PLATE XLIII

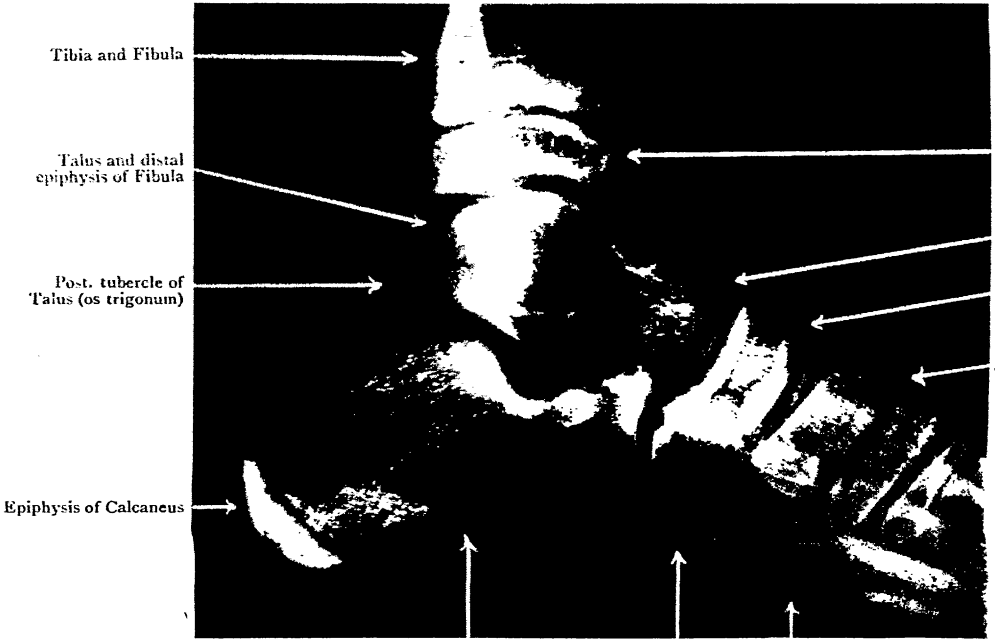

FIG. 194.—Lateral Radiograph of Ankle and Foot of girl aged 9.
Note the size of the epiphysis of the Calcaneus (cf. Fig. 188B), and that there is a separate centre of ossification for the posterior tubercle of the Talus; it may remain separate as the os trigonum. The sinus tarsi between talus and calcaneus is also well seen.

PLATE XLIV

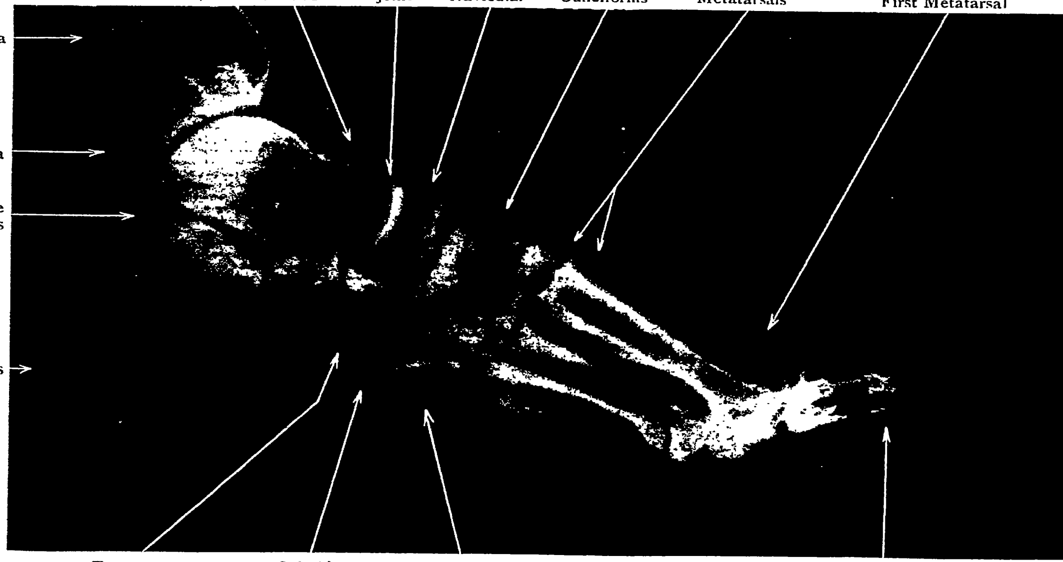

FIG. 195.—Lateral Radiograph of Foot of girl aged 17.

Note how the Medial Cuneiform overlaps the base of the Second Metatarsal. Cf. Fig. 188B.

[*Facing p.* 375

Dissection.—Divide the dorsal ligaments and draw the bones apart in order to see the interosseous ligaments.

The **navicular** bone articulates with the three **cuneiform** bones and is united to them by *dorsal* and *plantar ligaments*.

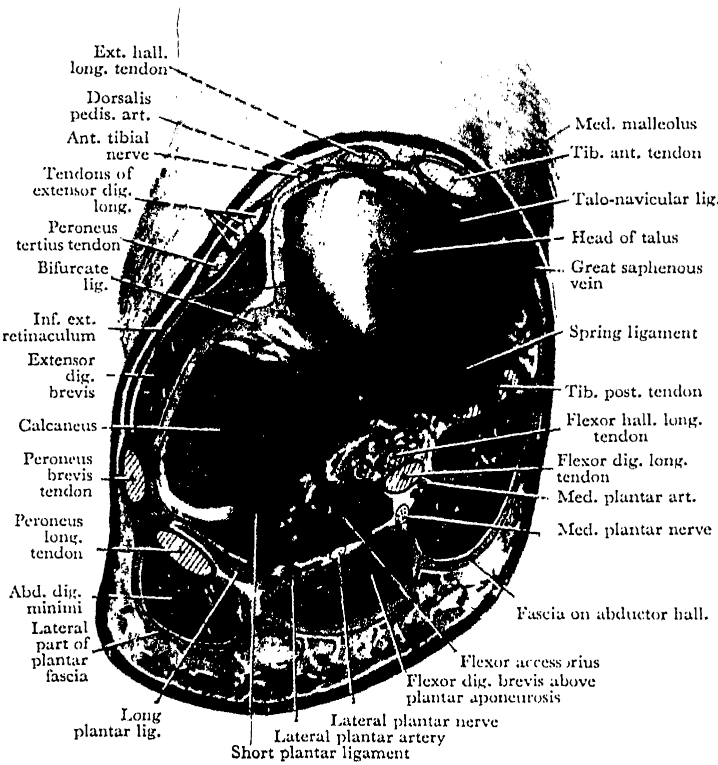

FIG. 196.—Section of Right Foot through Transverse Tarsal Joint.

The **cuneiform** bones lie in front of the navicular. They articulate together side by side, and are closely bound by *dorsal*, *plantar* and *interosseous ligaments*.

The **cuboid** bone lies lateral to the navicular and cuneiform bones. It articulates with the lateral cuneiform bone and, occasionally, with the navicular; and it is united to both of them by *dorsal*, *plantar* and *interosseous ligaments*.

Movements of Joints of Tarsus.—At most of the intertarsal joints, the only movement possible is the slight gliding of one bone on another that takes place when the arches of the foot are depressed by the weight of the body and when they spring up again as the weight is taken off; but at the *talo-calcanean* and *talo-calcaneo-navicular joints* the bones not only glide but can also rotate to a moderate degree on each other, giving rise to the twisting movements of the foot called eversion and inversion. Movements of gliding and slight rotation at the *calcaneo-cuboid joint* are associated with inversion and eversion; but the principal factor is the movement of calcaneus and navicular on the talus. In effect, all the tarsal bones below the talus are closely bound together and move as a unit on the talus. This can be demonstrated by fixing the calcaneus, when it will be found that the movements of inversion and eversion are impossible (Inkster).

In the movement of **inversion**, the sole is turned medially and the medial border of the foot is raised: it is naturally accompanied by some plantar-flexion, for in that position the talus can move a little sideways (p. 365). **Eversion** is the opposite movement, in which the sole is turned laterally and the lateral border of the foot raised: it is more restricted than inversion and tends only slightly to be associated with dorsiflexion. Both these movements can occur with the weight of the body on the foot, as in adjusting the foot to rough ground; but the movements of the foot as a whole are most easily studied on one's own foot off the ground. The possible extent of the movements of individual bones should be tested, and the line of pull of the tendons that pass from the leg into the foot should be observed. The muscles that *evert* the foot are the *three peronei*; the chief *invertors* are the *tibialis anterior* and *posterior*.

Tarso-Metatarsal Joints.—The bases of the first three **metatarsal bones** articulate with the three **cuneiform bones**, and the bases of the fourth and fifth articulate with the **cuboid bone.** The metatarsal bones are very firmly attached to the cuneiform and cuboid bones by *dorsal*, *plantar* and *interosseous ligaments*

There are only two constant interosseous ligaments. The most medial one—thick and strong—passes from the medial cuneiform to the base of the second metatarsal; the lateral one connects the lateral cuneiform to the base of the fourth

(and sometimes of the third) metatarsal, and shuts off the lateral from the middle part of the tarso-metatarsal articulation. A weaker interosseous band may pass from the lateral cuneiform to the base of the second metatarsal.

Dissection.—To bring the interosseous ligaments into view, divide the dorsal ligaments and bend the metatarsus forcibly towards the sole.

It is important to note that the line of articulation is irregularly indented; in particular the base of the second metatarsal bone is wedged in a kind of socket between the medial and lateral cuneiform bones, for the intermediate cuneiform does not reach so far forward as the others. (Figs. 191, 195.)

Articular Surfaces and Movements.—Examine the manner in which the metatarsus is implanted on the tarsus, and consider the extent of the movements that can take place.

The *first metatarsal bone* rests against the medial cuneiform bone; and this joint has a separate synovial cavity. It has a slightly greater range of movement than the rest of the series.

The *second metatarsal* articulates with the intermediate cuneiform; but its base is grasped by the anterior parts of the medial and lateral cuneiform bones, with both of which it articulates, and with both of which it may be connected by interosseous ligaments. It is not surprising, therefore, that this metatarsal should possess so little power of independent movement, and present a difficulty to the surgeon when he is called upon to amputate the anterior part of the foot through the tarso-metatarsal joints.

The *third metatarsal* articulates with the lateral cuneiform, against which the medial margin of the base of the *fourth metatarsal* also rests. The synovial membrane of the second and third joints is continuous with that of the joint between the medial two cuneiform bones, and through that with the synovial membrane of the cuneo-navicular joint.

The bases of the *fourth* and *fifth metatarsal bones* articulate with the cuboid. The cavity of the joint is separate from the other tarso-metatarsal joints, and more movement is permitted than in the case of the third.

Intermetatarsal Joints.—The bases of the lateral four metatarsal bones articulate with one another, and are very

firmly bound together by *dorsal, plantar* and *interosseous ligaments.*

Dissection.—To bring the interosseous ligaments into view, divide the dorsal ligaments and forcibly separate the bases of the bones from one another.

Joint Cavities of the Foot.—There are six separate joint cavities included in the intertarsal, tarso-metatarsal, and intermetatarsal articulations as a whole, viz.—

1. Talo-calcanean.
2. Talo-calcaneo-navicular.
3. Calcaneo-cuboid.
4. Cuneo-navicular, with extensions.
5. Medial cuneo-metatarsal.
6. Cubo-metatarsal, with extension.

Note particularly that one of these cavities is much more complicated than the others. It is prolonged forwards from the cuneo-navicular joint between the cuneiforms, and also between the cuboid and the lateral cuneiform; moreover, it extends beyond the tarsus and is continuous with the cavities that separate the bases of the second, third, and fourth metatarsal bones from the cuneiform bones and from one another.

The interosseous ligament which passes from the lateral cuneiform (frequently from the cuboid) to the fourth metatarsal bone separates this complex tarsal cavity from the cavity between the cuboid and the fourth and fifth metatarsals. That cavity is itself prolonged forwards between the bases of those two metatarsals.

Dissection.—Remove the abductor, adductor, and flexor brevis of the big toe, detaching them from the first phalanx and separating them carefully from the sesamoid bones. Next, divide the deep transverse metatarsal ligaments on each side of the second toe (if that has not been done), and trace the tendons of the interosseous muscles of the first two spaces to their insertion into the extensor expansion. Raise the extensor tendons from the joints of the first and second toes, separating them carefully from the synovial membranes. Then, clean the ligaments on the sides and plantar surfaces of those joints.

Metatarso-Phalangeal Joints.—These joints are formed between the heads of the metatarsal bones and the bases of the proximal row of phalanges. The base of the phalanx articulates with the distal or anterior surface of the head of the metatarsal when the joint is in the extended position, and with the plantar surface of the head when the joint is flexed.

The ligaments of each joint are a fibrous capsule and its thickened parts—the collateral and plantar ligaments.

The **fibrous capsule** surrounds the joint, and is attached to the bones near the margins of the articular surfaces. It is thickened at the sides to form the collateral ligaments; its plantar part is greatly thickened to form the plantar ligament; its dorsal part is exceedingly thin, and is fused with the ex-

tensor tendon, so that the extensor tendon is, in effect, the dorsal ligament of the joint and is lined with the synovial membrane.

Each *collateral ligament* is a thick, triangular band whose apex is attached to the pit and tubercle on the side of the head of the metatarsal bone. From that attachment, its fibres radiate to the side of the base of the phalanx and to the margin of the plantar ligament.

The *plantar ligament* is a thick, dense, fibrous plate. It forms part of the socket for the head of the metatarsal bone and articulates with the plantar surface of the head when the joint is extended. It is attached firmly to the base of the phalanx, and loosely to the neck of the metatarsal bone; during flexion and extension, therefore, it moves with the phalanx. Its margins give attachment to the fibrous flexor sheath, to the slips of the plantar aponeurosis, and to the deep transverse metatarsal ligaments. It forms part of the tunnel for the flexor tendons; its plantar surface is thus concave from side to side, and is lined with the outer layer of the synovial flexor sheath.

The plantar ligament of the first metatarso-phalangeal joint is almost all replaced by the *sesamoid bones* in the two tendons of the flexor hallucis brevis, which groove the plantar surface of the head of the metatarsal bone. Minute sesamoid nodules are developed occasionally in the plantar ligaments of some of the other joints. The first metatarso-phalangeal joint is much the largest, owing to the size of the bones and the presence of the sesamoids.

Dissection.—Pull the extensor tendons out of the way; divide the synovial membrane on the dorsum of the joint and the collateral ligaments at the sides. Flex the toe; examine the attachments of the plantar ligament, and note the sesamoid bones that replace it in the joint of the big toe.

Movements.—The metatarso-phalangeal joints are condyloid joints and therefore permit flexion, extension, abduction, adduction, and circumduction, but not rotation. Flexion and extension are brought about by the long and the short flexors and extensors, the flexors being aided by the interossei and the lumbricals. Abduction and adduction take place from and to the middle line of the second toe; and are carried out by the interossei (p. 344), the abductor of the little toe and the special abductor and adductor of the big toe.

Interphalangeal Joints.—These are constructed on the same plan as the metatarso-phalangeal joints; but the movements are more restricted.

Movements.—An interphalangeal joint is a simple hinge joint, permitting only flexion and extension; movements sideways are prevented by the pulley-shaped head of the proximal bone and the tightness of the collateral ligaments. In the lesser toes, at rest, the joints are, to a varying degree, in a state of partial flexion. The interphalangeal joint of the hallux is operated on by the long extensor and long flexor. The interossei and the lumbrical muscles aid the extensors in extending the joints of the other toes, and the interossei are the chief agents in extending the distal joints; the distal joint is flexed by the long flexor, and the proximal joint by the short flexor aided by the long flexor.

Hallux Valgus and Hammer-Toe.—The first metatarso-phalangeal joint is often enlarged and deformed, with permanent lateral displacement of the big toe. This condition, known as *hallux valgus*, is more common in women than in men; and dissectors should take any opportunity that presents itself in the dissecting-room to examine the relations of the parts in such cases.

Owing to the lateral displacement of the toe, the head of the first metatarsal bulges on the medial border of the foot; very frequently, as a result of boot-pressure, an *adventitious bursa* is formed over it; such a bursa, becoming inflamed, produces a painful swelling—a *bunion*.

The flexor tendons and the sesamoid bones are displaced laterally, and the head of the metatarsal and the sesamoids are often enlarged and irregular from osteo-arthritis.

In *hammer-toe*, the toe (usually the second) is permanently dorsi-flexed at the metatarso-phalangeal joint, and the normal flexion at the interphalangeal joints is accentuated. The flexor tendons and the plantar ligaments of these joints are permanently shortened.

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(Clarendon numerals indicate main references or descriptions, *e.g.*, Arteries, axillary, 24, **41**, 67.)